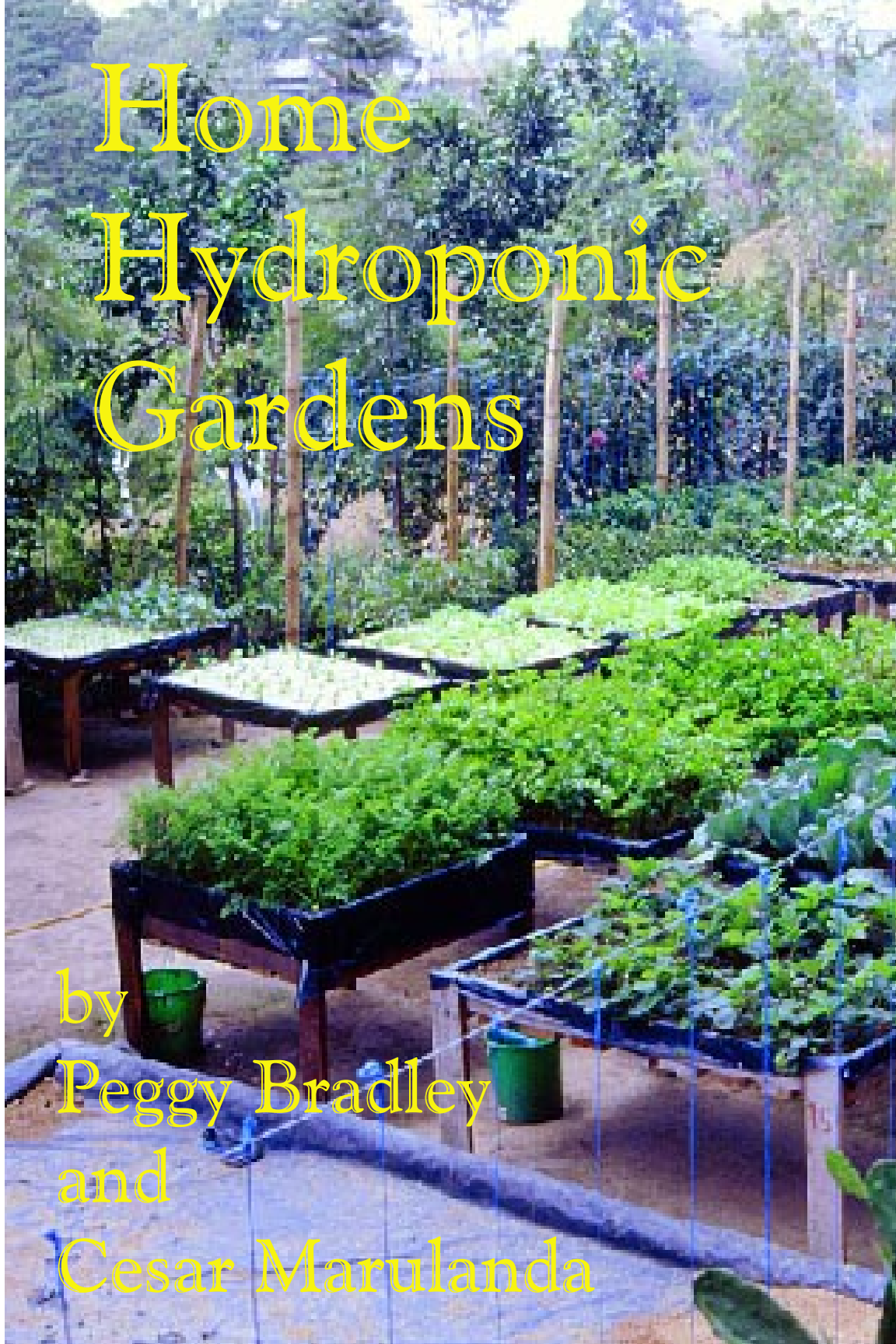

Home Hydroponic Gardens

by
Peggy Bradley
and
Cesar Marulanda

This is an important book that will make a difference. As we move into a new century, hunger around the globe is one on the main problems that must be tackled. Hydroponics provides one way in which groups of individuals can provide food for their families and start their own cottage industries. This form of growing food should be widely known - it can make a difference in inner city areas in the developed world as well as the developing world.

This book, written in an easy to read and clear form, provides information that can really make a difference in alleviating world hunger, improving the quality of nutrition, and thus the quality of life itself, for countless thousands around the globe."

Dr. Jane Goodall
Gombe, Tanzania

Home Hydroponic Gardens

International Institute for Simplified Hydroponics
USA

Peggy Bradley
and
Cesar Marulanda

Institute for Simplified Hydroponics

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I know that happiness does not come from things, even 20th century things. It can come from work and pride in what you do.

M. Gandhi

1. People and Gardens

Felipa Ruiz

Managua, Nicaragua

Neighbors only knew Felipa as "the lady who hollers". She lives in a one room tin roofed shack in the outskirts of Managua, Nicaragua. She is 76 years old and lives alone with her dog whom she talks to all the time.

Felipa has an acre of land with some fruit trees and her usual reason for hollering at neighbors was to keep them from harvesting any of her fruit. She worked as a housemaid cleaning floors and washing windows until she started her hydroponic garden.

Felipa was introduced to hydroponics by Cesar Marulanda who convinced her to try three growers in her garden. He explained that in hydroponics, the plants are grown without soil. Roots are placed in a "growing media" which replaces soil, and plant food is supplied in the water supply.

Felipa sold her fruit to a nearby market, so she had an idea where she could sell lettuce. She built the growers and in just 60 days after starting she sold lettuce and made $8.00 US. She realized that if she had more growers she could make more money. She decided to increase her growers to make $150.00 US per month. She took the profits from her first growers, and built more growers.

It was easy for Felipa to see the advantages of hydroponics over soil grown crops. Plants grown in hydroponic culture grow faster, sometimes four times as fast. They also use less water than soil based plants. For a person like Felipa who has to carry her water, this difference meant a lot less work.

Felipa now has reached her goal and sells $150.00 worth of lettuce and produce every month. She no longer cleans floors.

Cesar Marulanda

Armenia, Colombia

César Hernán Marulanda Tabares, a consultant in simple hydroponic systems, has established gardens in 15 Latin American and African countries.

Cesar Marulanda left his university job in Colombia to introduce hydroponics to people in need. Simplified Hydroponics is the name given to a simple hand pour garden system designed in Colombia. These hydroponic gardens require no energy other than human labor, and are constructed of recycled or very inexpensive commercial materials.

Simplified Hydroponic gardens have been established in at least fifteen countries in Latin America. Cesar Marulanda, hydroponics consultant and project designer, has been introducing popular hydroponics and training people to build their own backyard gardens. Grants from the United Nations and others have funded these projects.

Through over a decade of experience in these projects, Cesar has developed a hydroponic technology to produce vegetables in home gardens.

The gardens were inspired by the work of Jorge Zapp, a mechanical engineer who designed a project for Bogota in 1984. These gardens were hydroponic growers built of discarded wooden pallets. The pallets were lined with waterproof black plastic and filled with hydroponic media. Other containers were also constructed of other discarded materials such as washtubs and food containers.

Cesar Maruanda taught simplified hydroponics to 25 particpants at a workshop in Dakar, Senegal. Workshop participants hold up a basil from a floating bed grower.

Cesar, who has a Masters in Agricultural Engineering, was a horticulture professor, at nearby University of Tolima when he visited Zapp and the Bogota project. He was inspired by the potential of the gardens to offer people a means to escape poverty. Gardens built and operated by women with small children offered a means of providing money from a home based business. "I saw the gardens as a way of helping to solve many of the environmental problems caused by poor agricultural practices. The reduction in energy and resource requirements for the gardens offered a real hope to feed the earth's human population and reduce environmental impact."

Cesar was scheduled to go home that first day but stayed over for what turned out to be a three-day visit with many long conversations with Zapp. At the end of the visit, Cesar had decided to leave active teaching at the university and begin introducing Popular Hydroponics throughout Latin America. For the last decade he has been writing grants and working with the UNDP to do just that.

The simplified hydroponics technology offers real hope for any family to improve their living conditions. A garden of 20 bed type growers, can produce about 10 pounds of food per day. A 50 bed garden can produce from 25 to 50 pounds of vegetables a day, enough to provide an income to the garden owners.

In a recent workshop held in Dakar Senegal, 25 local residents were trained in building and maintaining their home hydroponic gardens. They built growing containers out of lumber and filled them with a growing media. Cesar recommended a growing media mix of rice hulls, sand, peanut shells and peat moss.

Workshop participants mix a growing media of 30% rice hulls, 60% sand, 5% peanut shells and 5% peat moss.

Neighbors gather round a small start up garden. The lettuce plants will be full grown in about one month.

The three-day workshop provides necessary tools, such as hammer, nails, staple gun, for building bed growers. Wood and plastic materials are provided so beginners can build from one to three of their own growers. Each grower is one by two meters surface area.

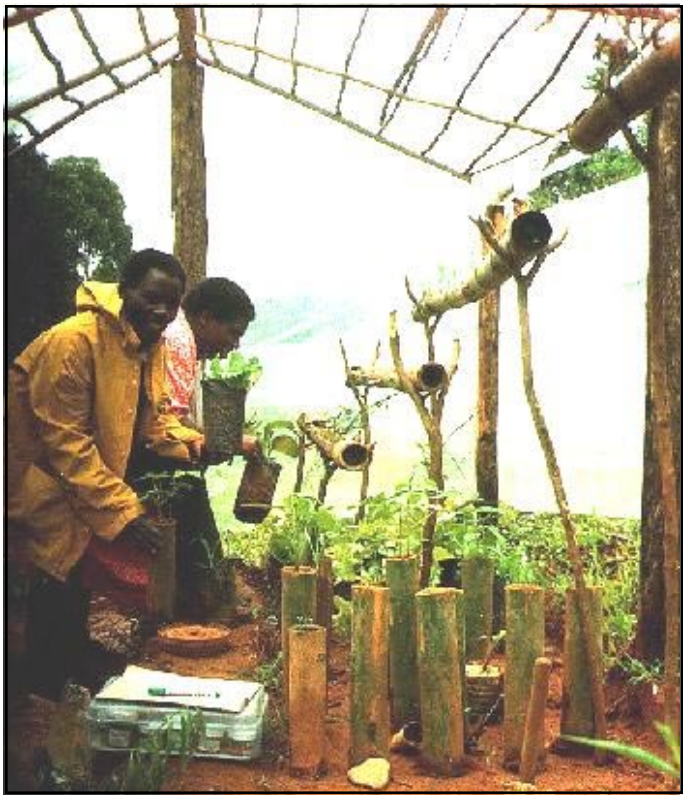
The small patio or backyard growers produce a crop of lettuce in 60 days. Each square meter of floating bed growers will produce one head of lettuce a day. So a three bed garden should provide a family with more than enough salad greens for a day's needs.

Once the lettuce beds are established, some of the garden owners can increase their numbers of growers, and grow more food for their families. A garden of 18 bed growers can grow about nine pounds of food a day in the tropics.

The nine pounds of food a day is about 25% of the families' daily food needs. It is fresh food produced cheaper than the cost of purchased vegetables.

Oliver Waziweyi

Mutare, Zimbabwe



Oliver Weziweyi setting up a hydroponic garden of bamboo growers in Zimbabwe.

A 50 year old Chigodora man, Mr. Oliver Waziweyi, says he has come up with an original idea that, if seriously pursued, could be a panacea for the increasing dearth of gardening space and water- hydroponics.

Mr. Weziweyi, who is also the Manicaland chairman of the Zimbabwe Farmers' Union Horticultural Commodity, told The Post at the just ended Manicaland Agricultural Show where he was exhibiting his "poor man's garden" that with hydroponics one does not need land or soil to grow vegetables.

"The idea is to conserve land and water and to fight hunger," he said. "You can grow your vegetables on any medium; perlite, gravel, rockwool, egg shells - virtually anything."

"We are fast exceeding the carrying capacity of the land. That we are now building upwards is testimony that we are running short of space. People who live in flats usually buy vegetables because they do not have the land on which to grow their own. Hydroponic gardening could be the answer to our problem."

He said the hydroponic garden has several advantages over the usual one. It is smart; one can work in it in a suit or wedding gown. It is interesting - particularly where a medium other than soil is used.

Vegetables grown under such conditions are free of chemicals like fertilizer, herbicides, or insecticides. Above all, it is generous on water consumption.

The hydroponic garden that he exhibited at the show occupied one square meter of land. It had 10 strawberries, four peas, 10 spinach, six covo, one pineapple, six shallots, 10 carrots, four herbs, two cabbages, three lettuces and several flowers. All these plants, which looked healthy and flourishing, were being watered with just five liters of water a day.

The vegetables are grown in bamboo sleeves 30 centimeters in height. A hole is then marked about four centimeters from the bottom of the sleeve, which will be closed. The bamboo is then watered up to the hole level, which acts as a regulator.

The water used has to be nutrified, Mr. Waziweyi said organic nutrients were available overseas but he could order them for interested people.

"You can also use readily available organic nutrients. All you have to do is find a small bit of soil, collect fishing worms. Introduce them to the feed box and feed them on kitchen leftovers. "Remove the worms and collect the soil and stir it in water and you have nitrified water!"

Alternatively, Mr. Waziweyi said, one can use bat droppings. "Bats come to your home on their own and leave you their valuable droppings for free. All you have to do is mix the droppings with water and use it to water your vegetables.

Chicken manure can also be used in the same way," he said, adding this had the advantage that the smell of droppings had a repellent effect on insects and hence no need for insecticides.

Peggy Bradley

Peggy Bradley started her own hydroponic garden when she was in college. "I could not afford fresh vegetables so I started a small hydroponic garden in Rubbermaid washtubs and storage containers. I grew plants in 16 containers or about 32 square feet of growing space."

Before I started the garden my food bill was running about $200.00 a month and after starting the garden my food bill dropped to $30.00 a month. Since nutrients only cost about $2.00 a month, my hydroponic garden really helped me financially."

Since her college days Peggy started her own hydroponics company that markets hydroponic educational kits and materials worldwide. She has a website at www.carbon.org and sells kits over the internet. She also works with Institute of Simplified Hydroponics, a US non-profit organization at www.carbon.org that establishes small hydroponic projects to help people raise their own food.

Peggy has a masters degree in Civil Engineering, and specializes in hydroponic systems that recycle all wastes. One of her designs, the hydroponic chicken coop, was nominated for Japan's international Technology and Science award.

Peggy has designed several kits to teach hydroponics to children. Some children's kits are being used in Africa and Latin America to teach children who may not have enough to eat. These kits are sold in the United States and donated into impoverished areas.

"Hydroponics can help the malnourished people in the world. That number is well over 1 billion people. With hydroponic technology, and worm farming to produce nutrients, a family can go from starvation and poverty to being self supporting. It is an exciting prospect that this technology can help so many, and my life is devoted to finds methods and means to teach this technology."

"Hydroponics also offers a great new hobby and a method to produce pure nutritious food. The website has a class for science students to begin to learn the process. We should be designing our homes and our gardens to include hydroponics. It offers a solution to many 21th century problems."

Children in a rural village in Mexico learning about hydroponics with the Children's Hydroponic Kit, complete with coloring book.

Alfredo Rodríquez Delfín

La Molina, Peru

Alfredo Rodriguez-Delfin shows germination in tub containers to a group of high school students.

Alfredo Rodriguez-Delfin is a professor of plant physiology at La Molina University in Lima, Peru. He has been working in hydroponic gardens since 1986 when he completed his biology thesis about growing potatoes in hydroponic culture. Following technology introduced by Dr. Ulises Moreno in Peru, Alfredo has tested a variety of crops and nutrients in pallet type bed growers at La Molina University in Lima, Peru.

Alfredo has concentrated on training and education, establishing a small pallet type garden for a family of about ten growers. He builds some of the bed growers 30 cm (12 inches) deep, for longer root crops.

Once constructed the growers are filled with a growing media. The growing media used in the Lima area is sand and gravel. Both substrates can be used through several rotations of crops without being replaced.

Hydroponics is taught in several nearby high schools and a contest is held for the best garden. In 1998, ten schools participated and in 1999, 50 schools joined in.

Students in a local high school come to the University to learn how to build hydroponic lettuce growers.

Alfredo also sets up small community workshops to teach hydroponic gardens for home owners. He recommends that a family garden should be at least 20 square meters of growing space.

Alfredo does not feel that expensive testing and monitoring equipment is required for home hydroponic gardens. He also supplies premixed liquid hydroponic nutrients to the community through a sales program at the University. The cost to the garden owner is about 20 cents per day. The cost is reduced to only a few pennies per day when the owner mixes their own nutrients.

Alfredo sees real promise for home hydroponic gardens in Peru. "We hope to continue our work to improve the lives of the people. We also wish to continue social, educational and commercial projects. Our small home hydroponic gardens help people produce their own vegetables or to produce vegetables for sale to improve their incomes."

Dr. Rodriguez- Delfin is in the process of writing grant proposals for more high school classes using simple hydroponic systems. He intends to include 300 schools in next years competition.

More Info: Rodriguez-Delfin, A. and Chang, M. 1999, Greening the Schoolyards of Peru with hydroponics, Practical Hydroponics, September-October 1999.

A home hydroponic garden made up of bed growers. Bed growers are approximately one by two meters (three by six feet). The floating beds, in the background with white covers, are used for lettuce.

A backyard hydroponic garden in Barquisimeto, Venezuela. Growers are made from discarded shipping pallets.

2. Your Hydroponic Garden

A home hydroponic garden in Nicaragua helps the family provide fresh food and extra income. The family garden (40m^2) can produce more than $75 per month.

Fresh vegetables can be grown at home in your own hydroponic garden. These gardens can be a very welcome addition to any home. The gardens can produce food at a fraction of the cost of store bought, and the food is usually of higher quality. When no herbicides or pesticides are used in the garden, the food may be poison free.

This chapter introduces a home garden made of 18 bed type growers. The garden can produce about four kilos (nine to ten pounds) of food a day. It includes five beds growing salad vegetables, seven beds growing root vegetables, and six beds growing table vegetables. The garden produces enough food to provide fresh vegetables for a family of four, and can provide about 25% of the family daily food requirements.

Outdoor gardens are seasonal in temperate climate

In the tropics, where the sun shines about 12 hours a day, food may be grown outside year round. In temperate climates, hydroponic plants cannot grow outside during the freezing winters. A climate controlled area must be set up and operated at an additional cost for year round home grown produce.

A home hydroponic garden, like any garden, requires diligence and care. Home hydroponic gardens can produce food about four times faster than soil grown plants, when proper management is followed.

Starting with bed growers

This garden uses bed growers, made from lumber and black plastic. The bed growers are simple to build, each requiring about two to three hours of labor. Complete instructions on building the growers are in Chapter 4. The garden can be gradually increased as more growers are built.

Why hydroponics?

Growing food with hydroponics offers many advantages over soil based gardening. Weeding is eliminated and physical barriers can help control pests. Growers can be placed at a convenient height for working. Plants are watered and fed daily, so the work in maintaining a garden is reduced to starting plants, transplanting and harvesting the food.

Hydroponics offers environmental advantages over traditional agriculture, which requires cleared land to plant crops. This can reduce wildlife and forest habitat, and cause loss of the topsoil layer from erosion. Soil agriculture practices may use herbicides, pesticides and fertilizers that can pollute the environment. This hydroponic garden recycles nutrients, so very little waste is released.

Potential health benefits

Hydroponic food is picked just before it is eaten so the vitamin values are retained. The flavors are usually excellent because the food ripens on the vine and is picked fresh when ripe.

Recent studies are showing that each person should eat at least five fresh fruits and vegetables a day. There is substantial evidence that this can reduce both cancer risk and heart disease.

Questions about health risks are associated with methods used for food production. With your own home garden you will know what was sprayed or not sprayed on the food. You will know the freshness and you will know the minerals provided to the plant.

Water conservation

It is estimated that soil agriculture requires nearly 300,000 gallons of water per year for each person. A home hydroponic garden can reduce those water requirements to only 10% of the soil agriculture.

A hydroponic growing shelter designed for young seedlings in Zimbabwe. A thatched roof has been replaced by plastic and the platform elevated to retain moist air.

A person's diet must fulfill two basic requirements, energy and nourishment. Energy is measured in calories and from 750 to 3000 calories a day are required. The amount is based on age, sex and energy used through the day (Table 1). This is roughly about three pounds of mixed food per day, so a family of four may require about 12 pounds of food every day.

The requirements for nourishment include adequate amounts of protein, fats and carbohydrates. A diet too low in any three will be deficient. Usually a person will continue to eat or feel hungry until these nourishment needs are met even if this includes extra calories.

Table 1. Calorie protein, fat and carbohydrate requirements of humans based on age (RDA,1989).

	Age in years	Calories Active	Protein grams	Fats grams	Carbohydr. grams
Children	1-3	1300	16	40	80
	4-6	1800	24	40	120
	7-10	2000	28	40	165
Males	11-51	2900	63	40	300
Females	11-51	2200	50	30	230

Source: RDA, 1989

Breakfast

Wheat cereal 1 cup
Soy Milk 1 cup
Sugar 1 tbsp
Calories 286
Protein 8 g
Fats 3 g
Carbohydrates 62 g

Breakfast of whole wheat cereal, sugar and glass of soymilk provides nutrition and energy requirements.

Lunch

Carrot, potato, onion, mustard and 1/3 cup dry soybeans.
Calories 317
Protein 25 g
Fats 12 g
Carbs 42 g

A lunchtime stew that uses mixed hydroponic vegetables with soybeans provides an adequate lunch in energy and nutrition.

Dinner Salad

Lettuce, bell pepper, radish, onion, tomato and watercress.
Soy oil dressing
Calories 100
Protein 2 g
Fats 9 g
Carbs 4 g

Squash soup

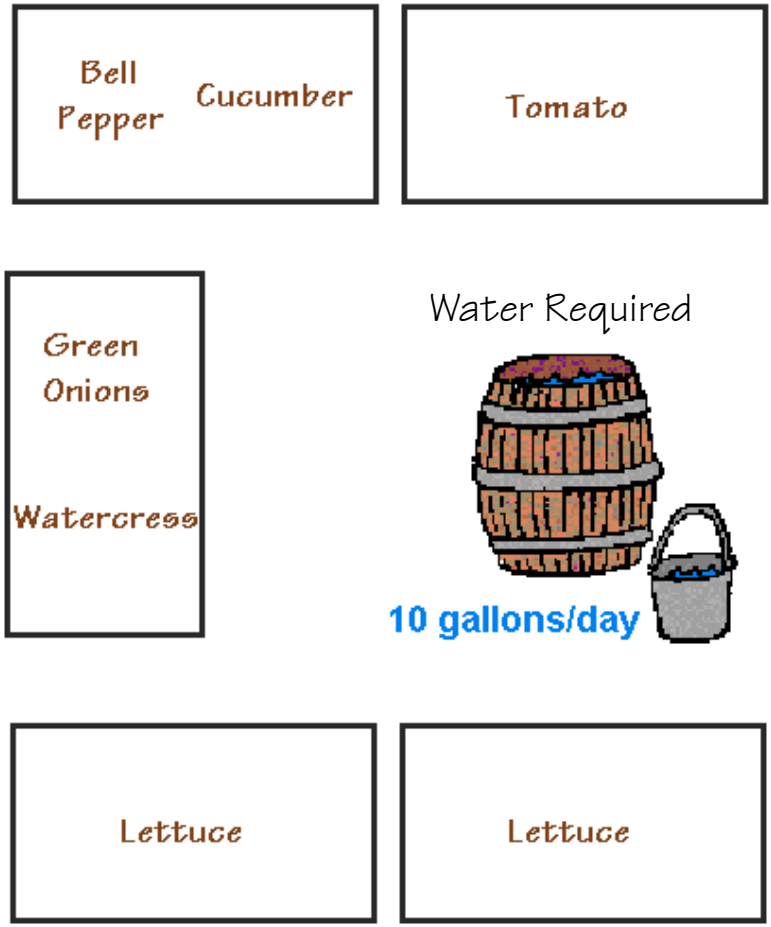
Hydroponic squash and onion
Calories 20
Protein 1 g
Fats .1 g
Carbs 18 g

Salad Vegetables

The salad vegetables produced in a five bed growers. It includes five tomatoes, two heads of lettuce, one bell pepper, green onions, watercress and cucumber.

Salad vegetables for the home garden include bell pepper, cucumber, lettuce, tomato and watercress. All are very productive in hydroponics and relatively easy to grow. The five bed growers should provide at least one daily salad for the family per day and fresh ingredients for other dishes such as sandwiches or tacos.

Salad vegetables should supply most of the necessary daily vitamins and minerals. Watercress is an important food to provide trace minerals. The four pounds of salad vegetables grown every day will provide about 95 calories for each family member. This amounts to 5 to 10% of daily food needs.



A garden of 5 bed growers can provide about 4 pounds of salad vegetables a day. This supplies about 380 calories, or about 95 calories for each in a family of four.

Table 2. Salad vegetables are very productive. A five bed garden can grow over four pounds of food a day.

	Beds	Garden produce					
Vegetable	($2\ m^2$)	g/day	oz/day	Calories	Protein	Fats	Carbs
Bell Pepper	0.5	152	5	41	1.4	0.0	9.8
Onions	0.25	90	3	34	1.0	0.1	7.8
Cucumber	0.5	93	3	12	0.6	0.1	2.6
Lettuce	2	743	26	97	9.6	1.6	17.2
Onions	0.25	90	3	34	1.0	0.1	7.8
Tomato	1	743	26	156	6.3	2.5	34.5
Watercress	0.5	46	2	5	1.1	0.0	0.6
	5	1959	69	380	21.1	4.6	80.3

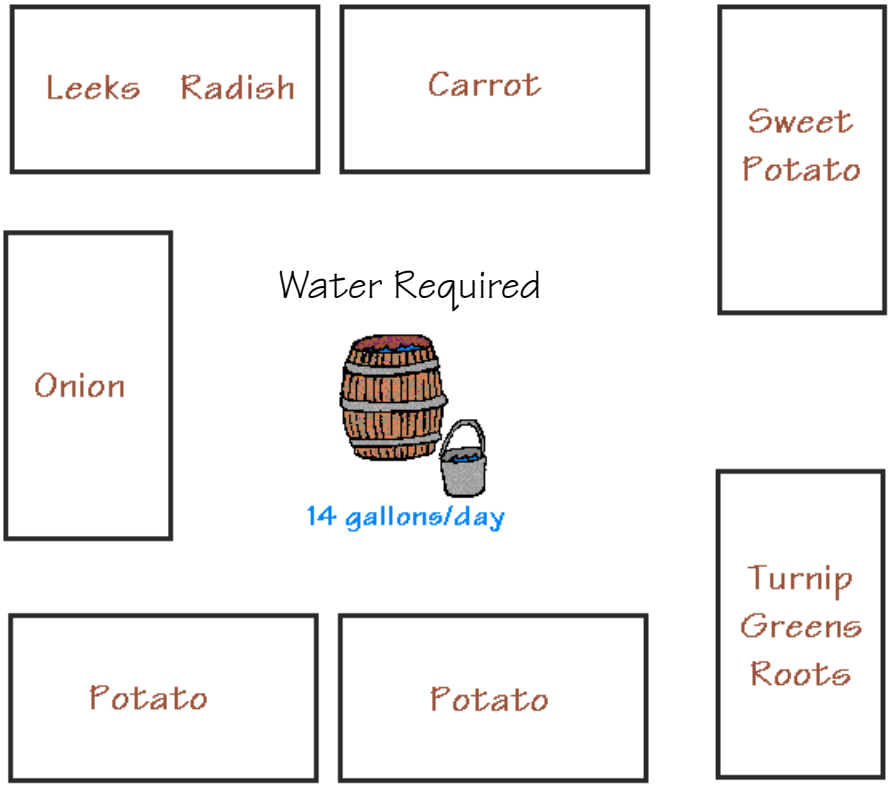
Root Vegetables

Daily root vegetables expected from seven bed growers. It includes four potatoes, one leek, one sweet potato, two carrots, one onion, one turnip and six radishes.

Root vegetables selected for this garden include carrots, leeks, onions, potato, radish, sweet potato, and turnip (greens and roots). The seven growers should produce about 3.6 pounds of vegetables a day. Together they can provide about 800 calories a day, or about 200 calories for each family member. This represents at least 10% of the necessary food for each in a family of four.

Many root vegetables are very important foods for a variety of cultures around the world. For example, potatoes were first cultivated by the people of South America and are a staple food in many countries around the earth.

Root vegetables can be used for side dishes, in stews or mixed into stir fry. Some root vegetables, such as potato, are usually cooked before eaten. Others, such as carrot, can be cooked or eaten raw. Most root vegetables are eaten cooked, and some require relatively long cooking times.



Root vegetable plan is for seven bed growers. They can produce about 3.6 pounds of vegetables a day.

Table 3. Root vegetables grown in a seven bed grower garden. They should be about 800 calories (200 calories per family member) or about 10% of the daily diet.

	Beds	Garden produce					
Vegetable	($2m^2$)	g/day	oz/day	Calories	Protein	Fats	Carbs
Carrot	1	186	7	80	2	0.4	19
Leeks	0.5	93	3	57	1	0.3	13
Onions	1	361	13	137	4	0.6	31
Potato	2	372	13	294	8	0.4	67
Radish	0.5	93	3	16	1	0.5	3
Sweet Potato	1	149	5	156	2	0.4	36
Turnip green	1	186	6	50	2	0.6	10
Turnip root	1	164	6	44	2	0.2	10
Total	8	1603	56	833	22	3	189

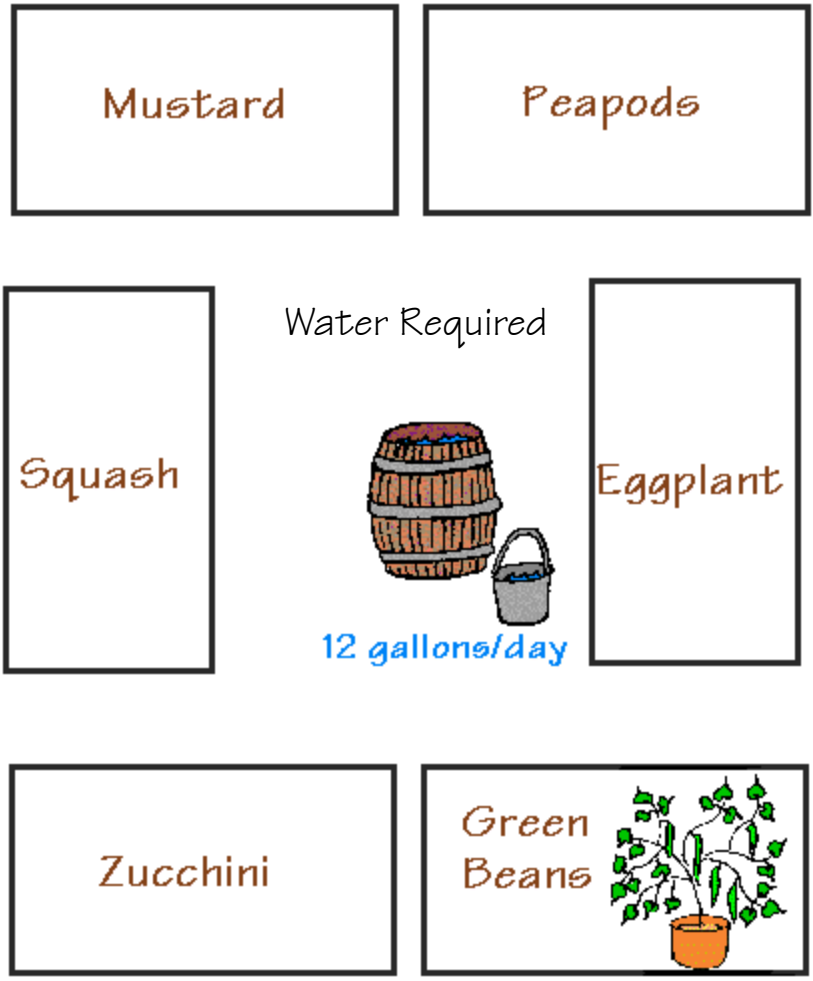
Table Vegetables

Daily table vegetables from six bed grower garden.

Table vegetables are often used as side dishes. The vegetables chosen for this garden are eggplant, green beans, mustard greens, peapods, squash and zucchini. A garden of six bed growers can produce about 1.6 pounds of vegetables each day or enough for some variety in stir fry, stews or dinner vegetables.

Table vegetables may have a better reputation among mothers than many children. A vegetable such as broccoli supplies very little nutritional value and so all table vegetables should be chosen based on family favorites.

Broccoli is a relatively poor choice because so little of the plant is actually eaten. Much of the plant is not used for food and this is wasteful in hydroponics. Peapods make a much better choice because a large part of the pea plant is edible, and the plant continues to produce as it is being picked.



A suggested garden plan for table vegetables.

Table 4. Table vegetables grow slower and produce less food value than salad and root vegetables. A six bed grower garden can be expected to grow about 1.6 pounds of food a day.

	Beds	Garden produce					
Vegetable	($2\ m^2$)	g/day	oz/day	Calories	Protein	Fats	Carbs
Eggplant	1	74	3	19	0.8	0.1	5
Green Beans	1	110	4	34	2.0	0.1	8
Zucchini	1	186	7	26	2.2	0.3	5
Peapods	1	149	5	62	4.2	0.3	11
Squash	1	74	3	19	0.7	0.1	5
Squash seeds	1	6	0.20	29	1.8	2.3	1
Mustard Greens	1	141	5	37	3.8	0.3	7
Totals	6	739	26	227	15	3.5	41

Staple foods

Staple foods are those foods which provide basic nutritional needs. They can be produced in hydroponics, but require more space and nutrients.

Staple foods are those foods which supply most of your families nutritional requirements. Most edible staple foods such as rice, corn, peanut, dried beans, and wheat, are the seed part of a plant. This is usually a very rich source of food, where the plant has stored materials for the next generation's success. It is a small portion of the plant, and most of the plant part of a staple food is not eaten. This means a lot of hydroponic nutrient, time and water went into the portion of the plant not used.

In most cases, staple foods should be purchased and stored rather than grown in a hydroponic garden. In this garden design, staple foods are not in-

cluded as they are often the hardest and most expensive to grow in hydroponics.

Staple foods in your garden may require about 10 bed growers per person. It also costs more for the nutrients used for the plants, as much as one pound of nutrient to grow five to ten pounds of food.

Table 5. Staple food production in hydroponic beds. Each vegetable requires 10 of the 2m² bed growers.

Beds Garden Produce							
Vegetable	Beds	Grams	Ounce	Calorie	Protein	Fats	Carbs
Garbanzos	10	140	5	510	27	8	85
Durum wheat	10	300	11	1017	41	7	213
Lentils	10	200	7	676	56	2	114
Kidney Beans (change vales)	10	388	14	438	27	3	78
Peanuts	10	160	6	907	41	79	26
Quinoa	10	300	11	1122	39	17	207
Rice brown	10	200	7	724	15	5	152
Soybean cook	10	206	7	857	75	41	62
Sunflower seeds	10	200	7	1140	46	99	38
yellow corn	10	229	8	837	22	11	170

Even after growing nine pounds of food each day in your hydroponic garden, most of your families food needs must be provided by staple foods. When planning your hydroponic garden it is important to recognize that staple foods required for your family may have to be purchased and stored.

The garden designed in this chapter will produce about one fourth of family food needs, and this can easily include all fresh vegetable requirements.

Depending upon the Garden

Almost every long term successful human society or culture relied on a food store. Many cultures tried to maintain a seven year food supply. In the case of a hydroponic garden, extra food should be preserved and stored. The hydroponic garden is a benefit and can help maintain family health, but not depended upon for day to day survival. Any crop can fail.

Combining foods for complete protein

For a vegetarian diet to be complete in protein, foods should be combined at every meal. A meal with soybean and wheat together is more nutritious than one with just one of these. Likewise beans and rice can be eaten together, or beans and corn. Also, soybeans and rice can make a complete meal.

Of all staple foods that can be grown in hydroponics, soybeans offer the most nutrition for resources used. Soybeans have a high fat content, part of a nutritious diet. Soybeans can be made into milk, flour, a soy nut snack or used as beans in cooked dishes. Soybeans must be cooked to make the food value digestible.

Table 6. A meat substitution table. To provide full protein, vegetable staple foods should be mixed at every meal.

Food	Amount	Weight	Calories	Protein	Fats	Carbs
Round steak		**8 oz**	428	70.5	13.8	0
Substitute # 1						
Soybeans and wheat		eaten together				
Soy flour	1 cup	8 ounces	418	45	13	36
Whole wheat flour	1 cup	8 ounces	394	12	1.1	84
Total			812	57	14.1	120
Substitute #2						
Beans and rice						
Kidney beans cooked	1 cup	260	234	14.8	1	42.6
Rice cooked brown	1 cup	150	178	3.8	0.9	37
Total			412	18.6	1.9	79.6
Substitute #3						
Beans and corn						
Kidney beans cooked	1 cup	260	234	14.8	1	42.6
Corn	1 cup	200	132	3.8	1.2	31.4
Total			366	18.6	2.2	74
Substitute #4						
Soybeans and rice						
Soybeans cooked	1 cup	200	260	22	11.4	21.6
Rice cooked	1 cup	150	178	3.8	0.9	37
Total			438	25.8	12.3	58.6
Substitute #5						
Soy milk and wheat cereal						
Soymilk	1 cup	240 ml	120	4	2	21
Wheat cereal	1 cup	35 g	120	4	1	28
Total			240	8	3	49

Plastic tub hydroponic growers planted with tomato. The tubs produce tomatoes all year in a greenhouse.

Children in Zimbabwe show their hydroponic produce grown in native bamboo containers and tubes.

The children in a family can participate in the daily tasks of a garden.

César Marulanda observes the progress of a home garden in Colombia.

3. Location

A hydroponic garden can be set up on a roof top, a balcony, a stairway, or almost anywhere with at least six hours of bright sun. The garden should be located on the sunny side of the house or perhaps on the roof. If the weather gets too cold or the day length gets too short, the garden will quit growing and producing, so you may have to bring the garden indoors or keep it warm in a sheltered area.

Hydroponic plants will grow faster with more sunlight. Areas shaded by trees or right next to houses and other obstacles to light should be avoided. Any areas that are exposed to high winds should also be avoided.

Hydroponic growers can be grown in the open, or in a sheltered greenhouse. In the tropics, where the air temperature stays above (7.2^{0}C) 45^{0}F year round, the hydroponic garden should produce food outside all year. In areas with heavy rainfall, it may be necessary to shelter the garden with a transparent plastic roof.

In temperate climates, the hydroponic garden will grow outdoors during the growing season, but must be sheltered during winter when plants cannot grow outdoors.

A plant grows by using sunlight to provide energy. On a sunny day, approximately 1/3 of energy converted from sunlight by a plant is used for the plant's survival. If all sugar produced that day is spent on survival, the plant will not grow. In the temperate climates, it takes lettuce only about one month to grow in summer months, when temperature and sunlight are best, and five months to grow in winter, when sunlight is reduced.

Plants grown indoors, with optimum growing conditions, can grow very fast. If properly cared for, plants can provide a large amount of edible food.

Environmental Conditions

Light

It is best if plants have at least six hours of sun in the tropics or eight hours of sun in the temperate climates. Artifical light has a quality or spectrum, and some lights produce a better spectrum for some plants and not for others.

Temperature

Very few plants can stand temperatures below freezing. Some trees can survive winters but most herbs and vegetables die off when their roots freeze. Most plants grow best in daytime temperatures of 75°F and night temperatures of 60°F.

Water and Air

All plants require water and obtain most water through their roots. Water with air is needed for the roots of the plant to live.

The location of the garden should be near a source of clean dependable water. If water has to be hand carried, a garden of 10 bed growers (20 m^2) can use about 80 liters (20 gallons) a day.

Security

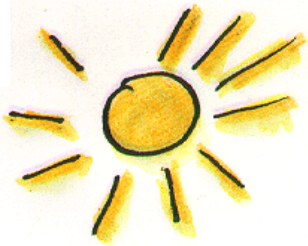
The garden should be fenced in or protected to keep out domestic animals and irresponsible people. If it is not possible to isolate the garden from this type of animal or person, the recommendation is not to invest any effort, as sooner or later it will be lost, causing great frustration.

Space Required

Space of the garden can vary. Gardens as small as 6 m^2 provide food for the family, and spaces as large as 200m^2 are successful family gardens, providing extra income. Most gardens are between 10 and 20 m^2.

Location for a garden

1. a minimum for six hours of tropical sun (eight hours of temperate sun) each day



2. near a water source

3. not exposed to strong winds

4. near the place hydroponic nutrients are prepared and stored

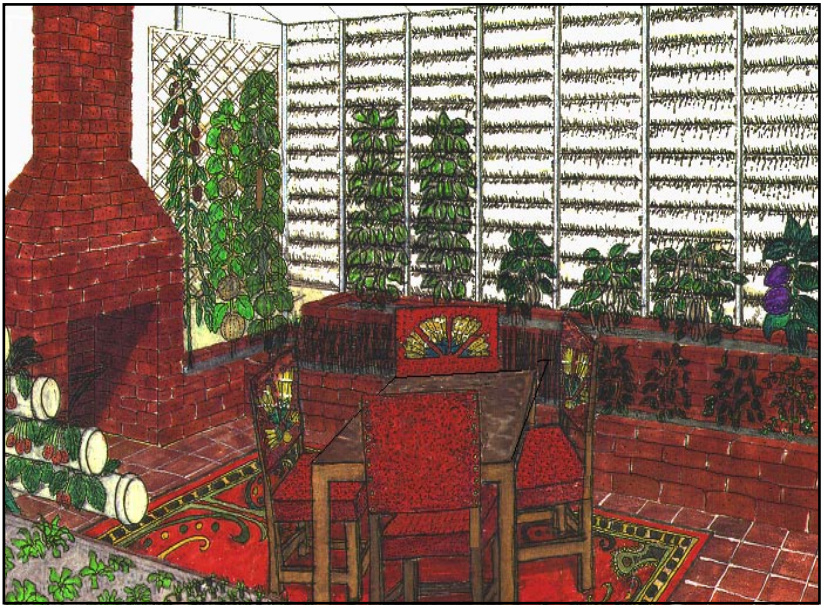
5. not excessively shaded by trees or buildings

6. protected from domestic animals and irresponsible people

7. protected from severe climate conditions

8. not near sewage or industrial wastes

Temperate Climate Control

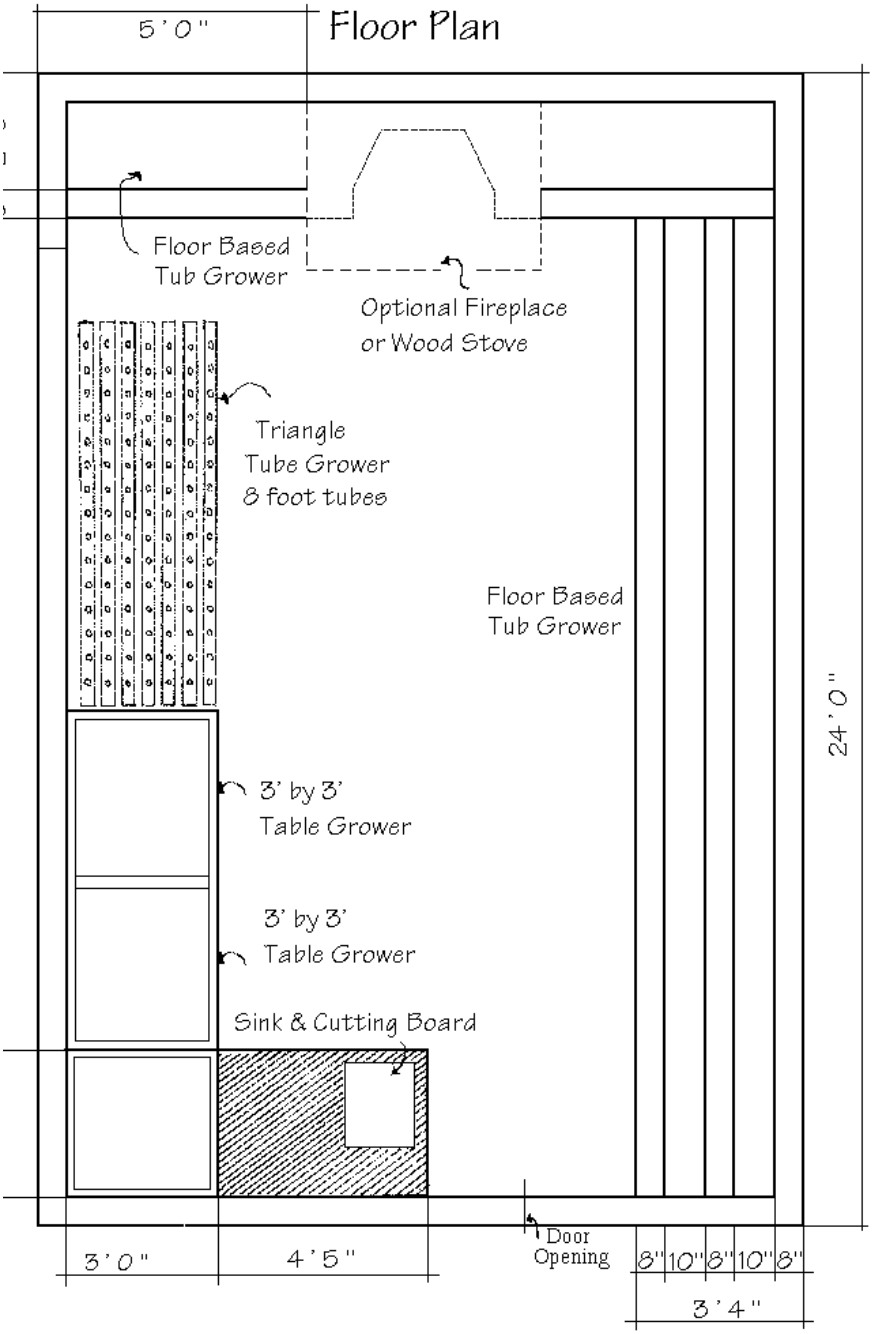


A 16 by 24 foot greenhouse is designed for the temperate climates. It includes a fireplace, food preparation and dining area.

In the climates with winter days of freezing weather, plants cannot produce. For year round production in temperate climate, a climate controlled growing area is needed. This can be an exterior greenhouse, or part of the home devoted to plants.

The costs of operating a greenhouse in the winter can be great, and food can be expensive. A small greenhouse can easily cost $50.00 for energy every month. The design of the greenhouse will affect costs.

Peggy operated her hydroponic greenhouse year-round without using any additional lighting in the winter. Winter food was very slow growing so she started the winter season with all growers loaded with food. By the spring most had been harvested. Onions stay alive, but grow slowly through winter. Tomatoes produce only about half as much food.



To raise food year round in the temperate zones, a greenhouse structure is needed. It provides climate control that allow the plants to survive and grow.

Container hydroponic growers can be moved to better growing conditions.

Some hydroponic growers made of bamboo are used in a shady area for young seedling starts

4. Growing Containers

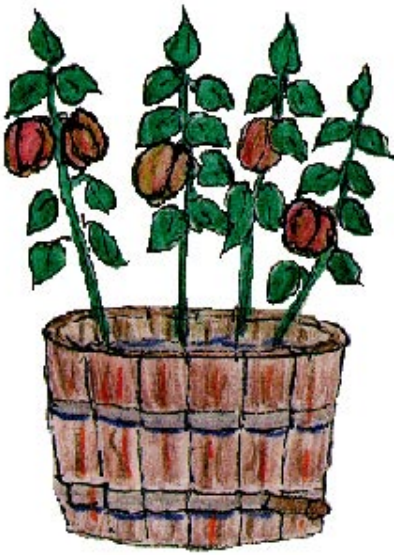
Hydroponic growers can be made from many types of containers. Discarded things such as plastic cups, margarine containers, plastic ice cream tubs can all be used for smaller growers.

Larger tubs, wood boxes and baskets can also be used for small seedlings and some types of plants. Bed growers or troughs can be built of lumber, concrete or the earth itself in the form of adobe or compacted earth.

Chives in a plastic butter dish

Snow peas in a plastic cup

Herbs in a 5 liter (5 quart) container



Bell pepper in a half wooden barrel

Tub Growers

A tub for hydroponics can be any watertight object that does not let light through. While a plastic storage container is shown, many other materials and containers can be adapted for use.

Almost any clean waterproof container can be used to construct a simple hydroponic growing system. A growing container can be assembled from reusable, natural or hand crafted materials. A growing container needs to hold water and be made from a sturdy material. It should be something that light does not penetrate to discourage algae growth.

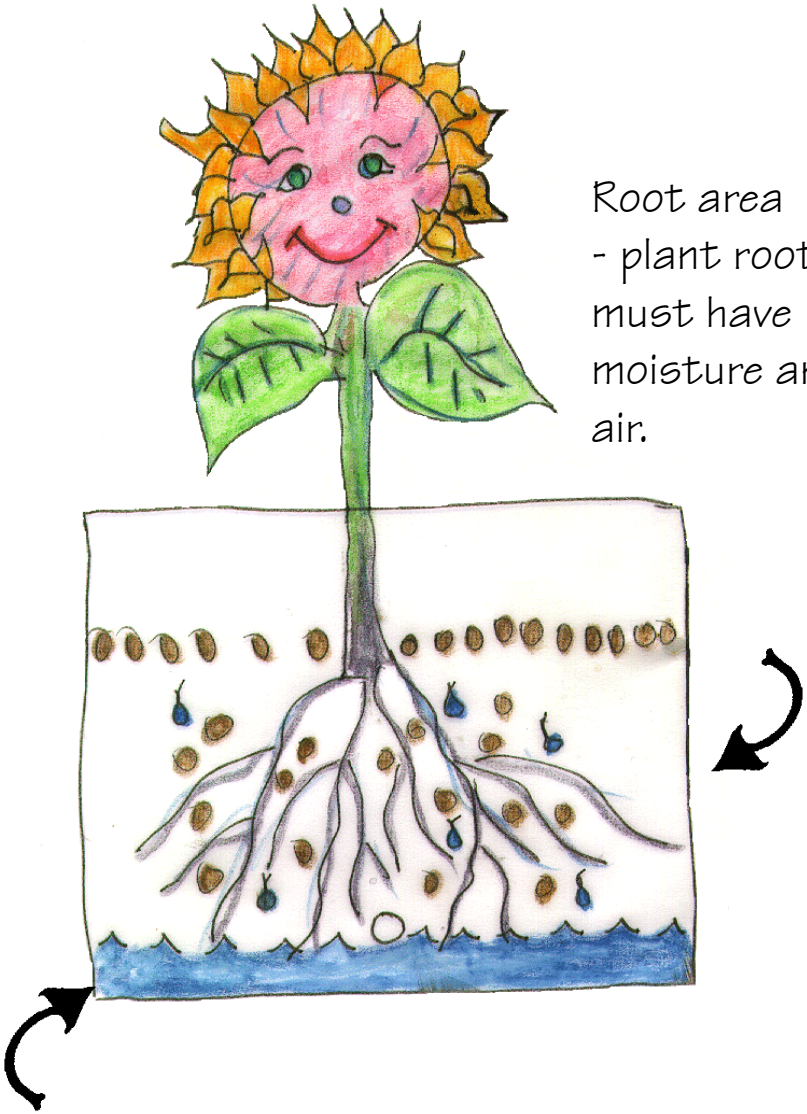
Reused containers and materials could be contaminated with something that could make you ill. Wash all materials thoroughly before using. When reusing any material, try to discover what it was used for previously. If it contained food, it is probably safe for hydroponics. Containers that held chemicals like pesticides, herbicides, toxins or poisons should never be reused.

Making a Tub Grower

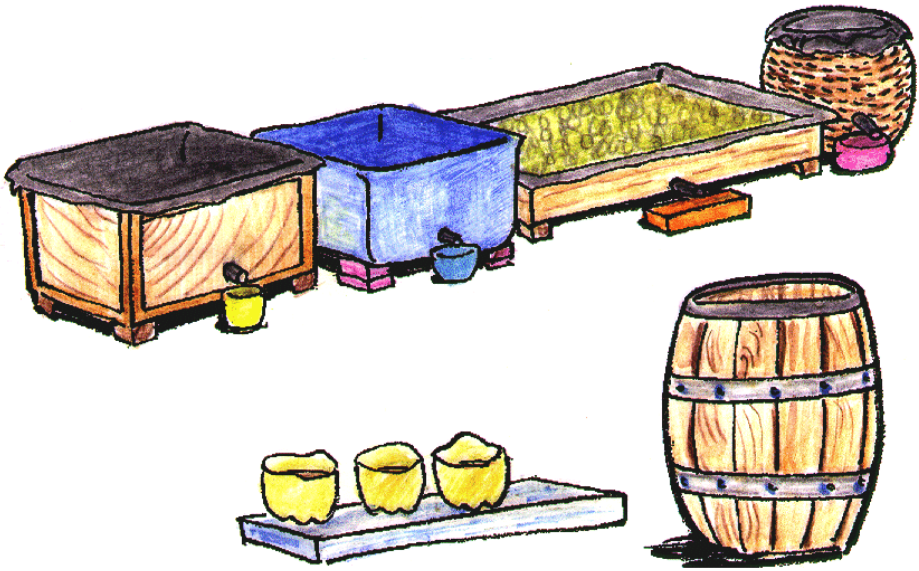
First, a hole must be cut or drilled in the front of the container.

Cut hole 2.5 cm (1") from the bottom.

A piece of hose, black tubing, or bamboo is placed in the hole to make a drain.



Water level is below the drain hole - plant roots always have all the water they need. There should be enough water for at least one sunny day.



A garden can be set up of many individual growers. Each should have a drain and a container below to catch any excess water.

A container should be

1. Waterproof - the only water leaving the tub should be from the drain hole.
2. Non-see-though - Light should not get to the root area so the darker the container, the better.
3. Able to be drilled - or cut to insert a drain hole.
4. Non-toxic - some containers have been used for chemicals or non-food products. Try to use things that were used for food.

Precautions

1) Clean Water
Always try to obtain clean water. Clean water can be stored rainwater or water from a clean natural source. Contaminated water is very common and should not be used.

2) No chemical pesticdes
Do not use pesticides, herbicides or fungicides in your hydroponic garden. Keep a spray bottle with a little mild soapy water handy to drive away insect pests. Wash the plants by spraying with a large amount of nutrient solution if their leaves they look like the have a fungus. If a crop becomes infested with pests, fungus or any plant disease, you may need to throw the crop away and start over.

3) Beneficial Insects
Try to keep beneficial insects such as ladybugs around your hydroponic garden. A few spiders also help hold down pests. It also helps to plant insect inhibiting companion plants.

4) Stored Food Supply
Store a food supply and do not depend on the hydroponic garden for all your food. Consider the garden an added benefit and once it begins to produce, it should lower the cost of your food bill. Some food must be available for days when garden does not produce or the crop has failed.

Bed growers are being made of lumber. A stack of styrofoam will be used to make floating beds for lettuce.

A group of neighbors water and inspect new seedling bed growers. Growing media is a mixture of rice hulls, sand, peanut shells and moss.

Bed Growers

One of the most useful growers in a hydroponic garden is a simple bed grower. The first bed growers were made of shipping pallets with legs added to the bottom to raise the bed. They can be built from lumber.

There are two types of systems used in bed growers, growing media and floating beds.

Growing Media

This grower uses hydroponic media, and includes a drainhole at least 1.5 cm (2/3") above the bottom surface of the grower. This allows for a thin water table at the bottom of the media that serves as a daily water store. The table growers with media are used for growing lettuce as well as tomatoes, bell peppers, herbs and other vegetables.

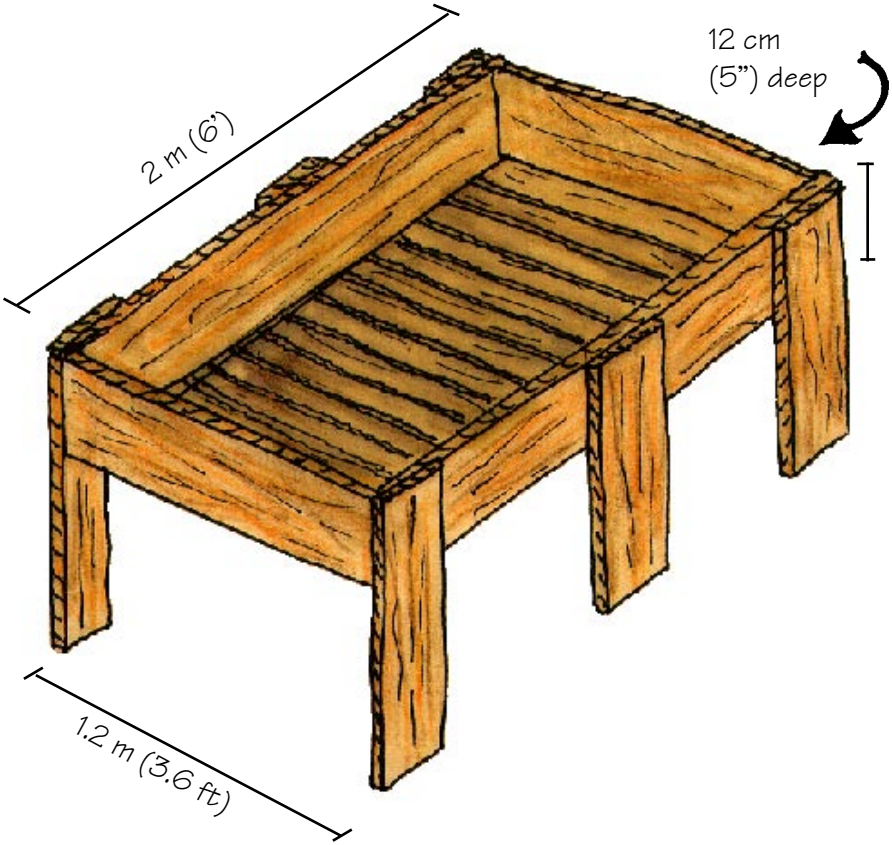
The drained media growers are hand watered every day. Each square meter of growing area will require from 2 to 3.5 liters (1/2 to 1 gallons) of nutrient water per day.

Floating Beds

In a floating bed grower, the bed area is filled with standing water, and a white foam board is placed over the grower. Holes are burned into the Styrofoam with a hot tool. The foam is then placed over the water is used to support growing lettuce.

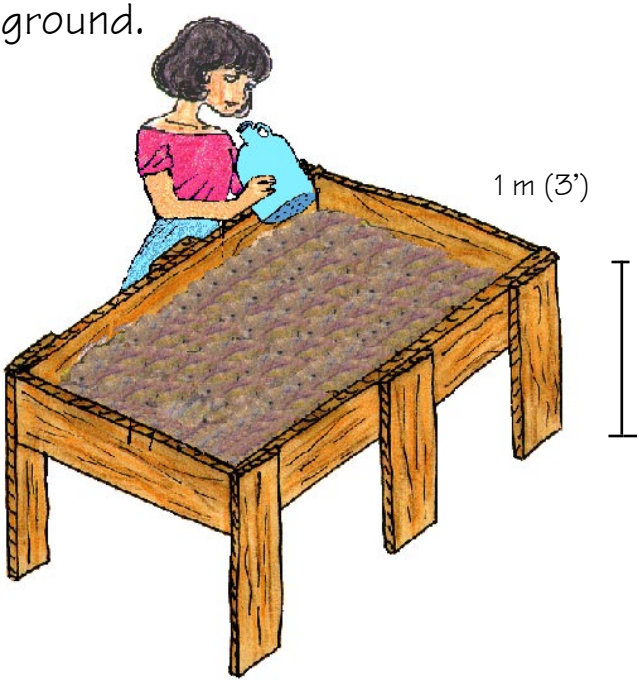
Lettuce seedlings are placed in pieces of sponge and then put in the Sytrofoam. Lettuce roots hang down into nutrient water below. Floating bed nutrient water is hand stirred twice a day to provide a healthy root environment.

Making a Bed Grower



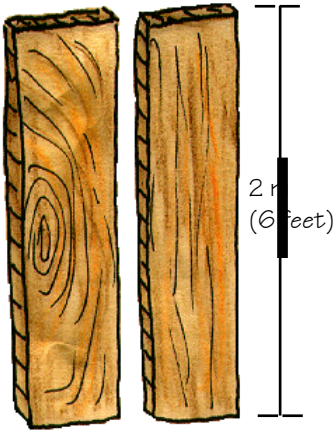
Bed growers are made out of wood and lined with plastic. They can be used for growing media or floating beds and the legs can be from 0.32 to 0.65m (1 to 2') tall.

Bed Grower should be at least 20 cm (8") above the ground.

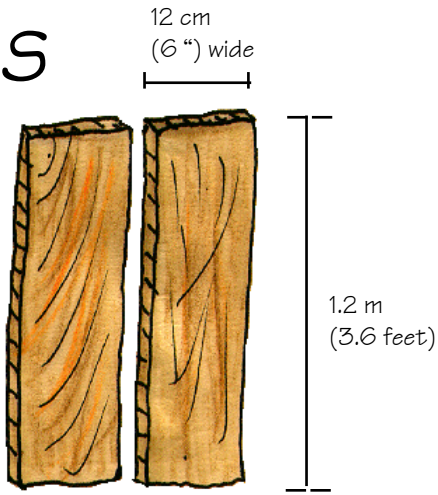


Legs of one meter make gardening easier and provide more protection from animals and small children. They will cost more because of the extra cost of wood.

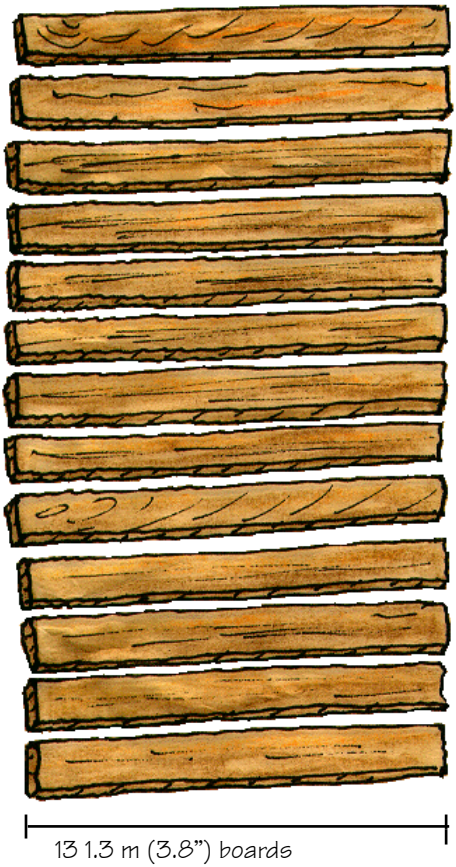
Materials



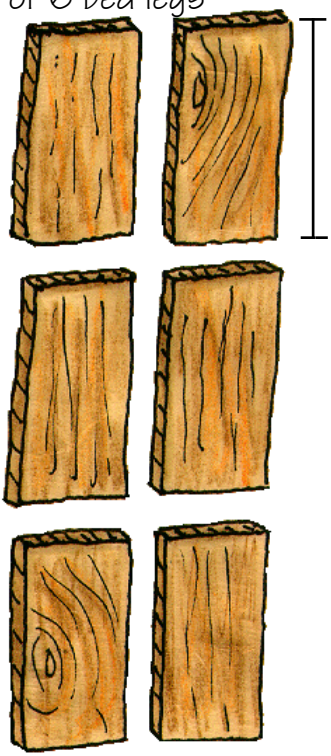
2 sides of the bed

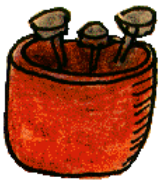


2 ends of the bed

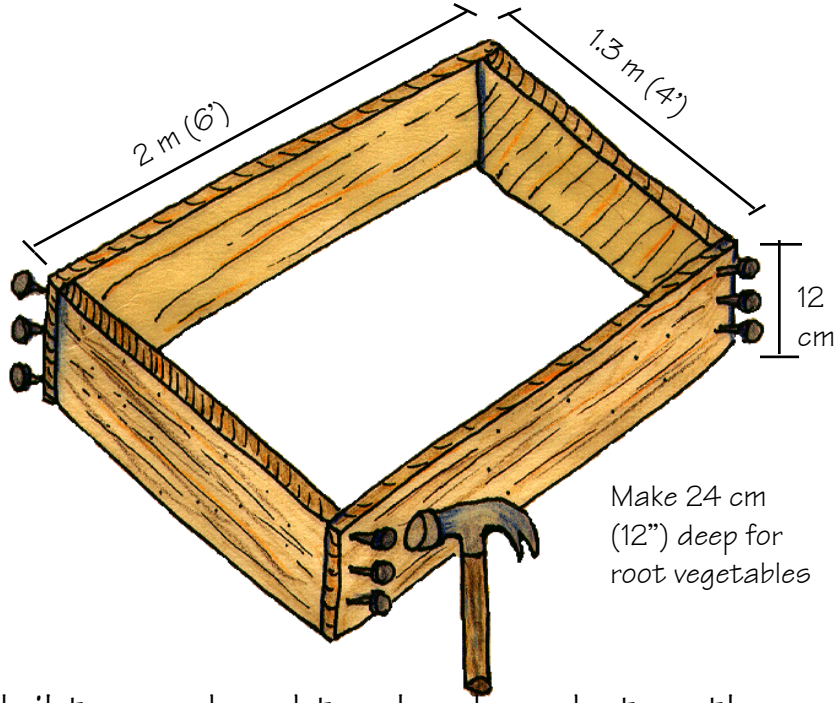


4 or 6 bed legs

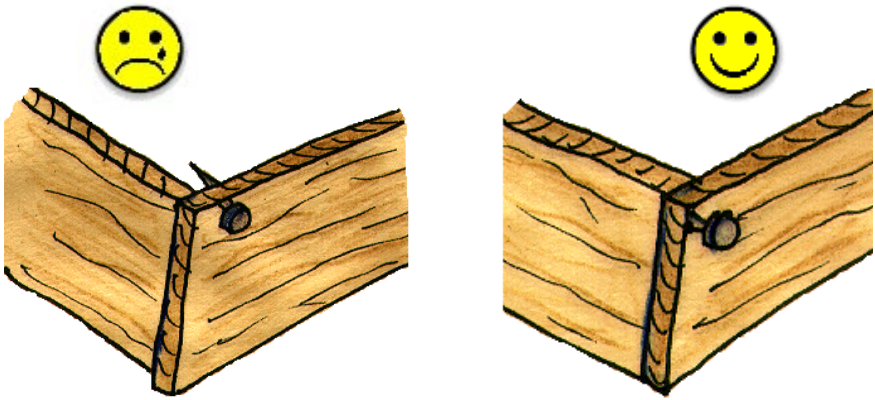




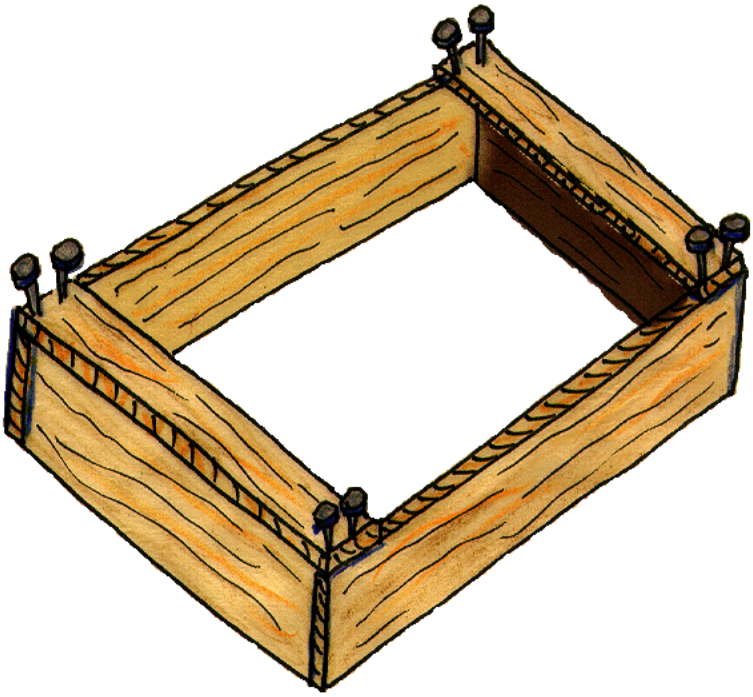
65 nails of
1.5” long



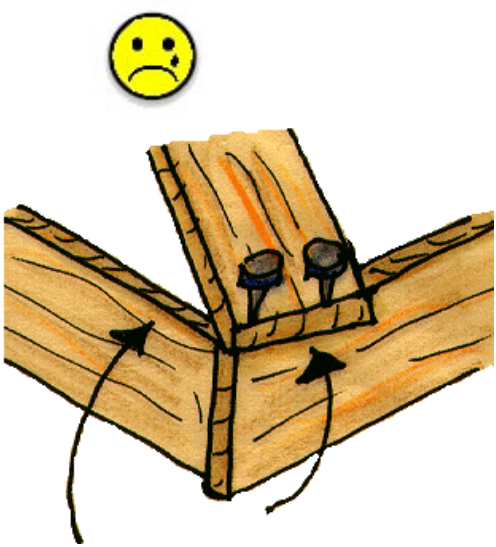
Nail two end and two box boards together with end boards placed inside the longer boards. Nail together with at least two nails, (three make it stronger) making sure nails do not leave any sharp edges inside the box.



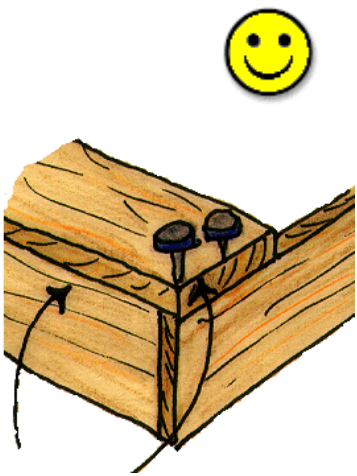
No nail points should be snowing as they can rip the plastic liner.



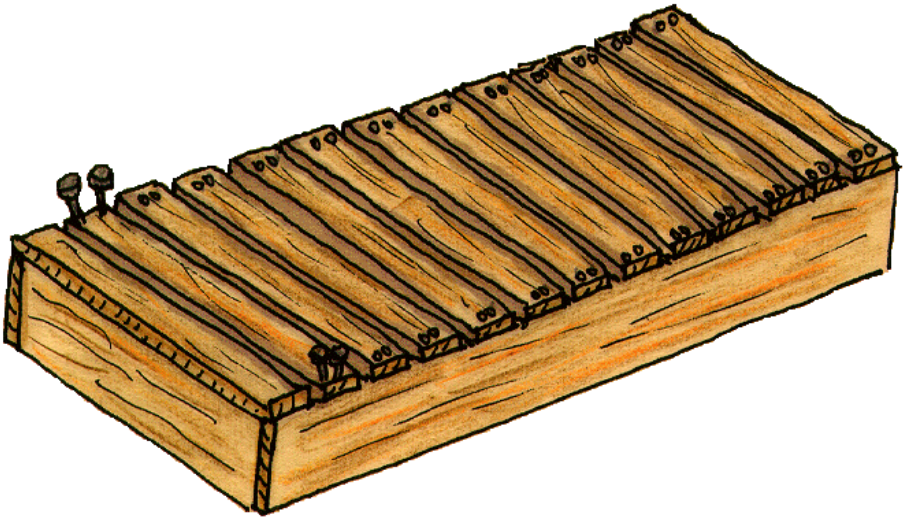
The 1.3 m boards are nailed across the bed-frame. The two end boards are nailed first and must be perfectly aligned with all sides of the frame.



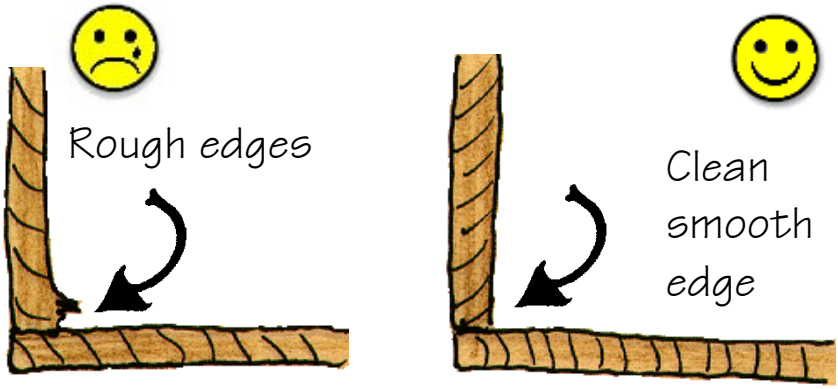
Edges not aligned



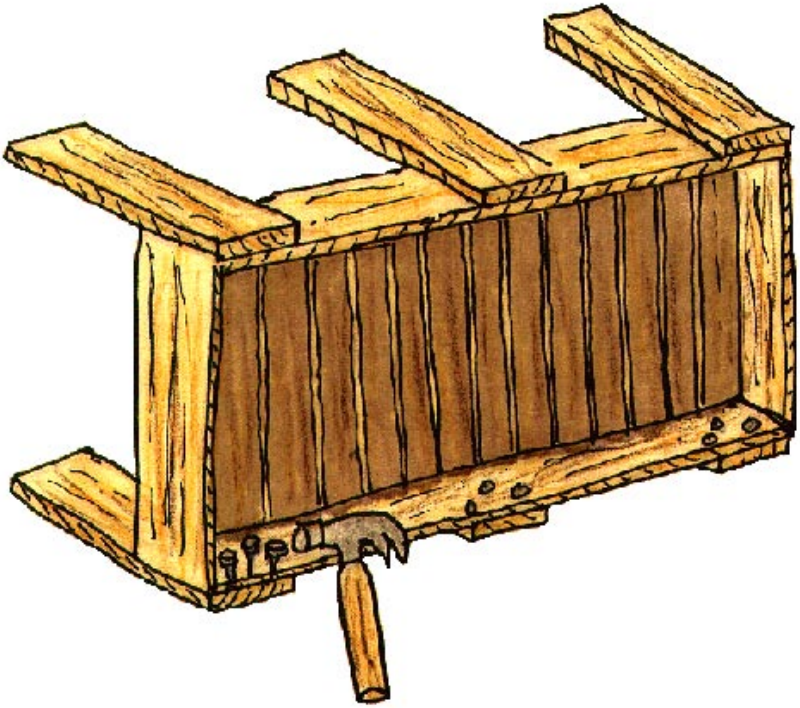
Edges aligned



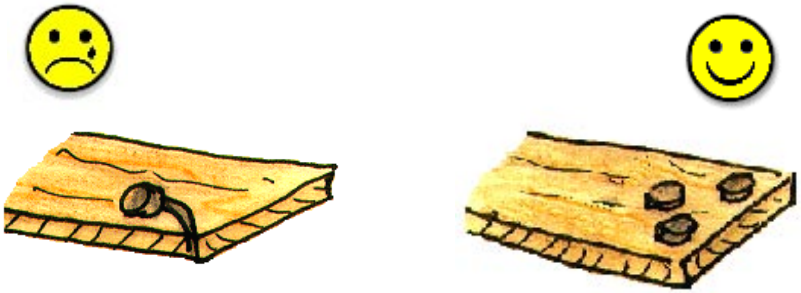
Box frame is completed by nailing remaining boards with 3-4 cm (1.25-1.5”) space between each board.



Make sure all corners and edges are even and there are no rough edges on the inside of the box that could rip the plastic bed liner.

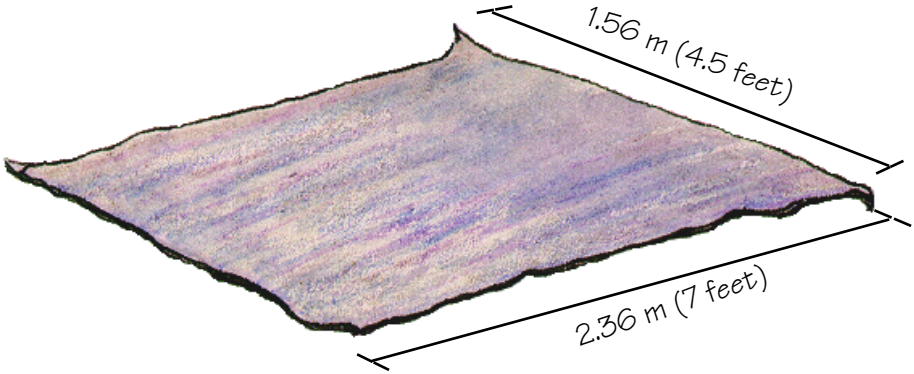


Four or six legs are attached to the box, one on each corner and one on each side. All nails are placed on the inside of the box and hammered to the outside. Nails should be carefully hammered down so no rough edges appear. Three 1.5" nails in triangle are enough inside.



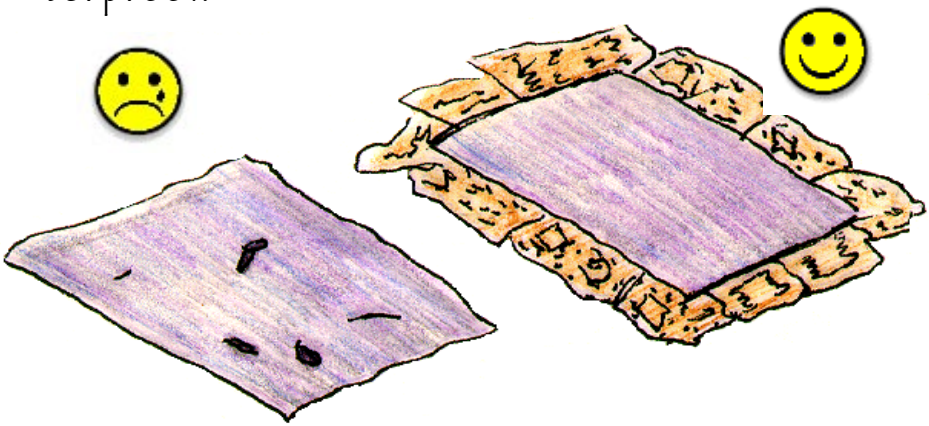
Bent nails can tear plastic

Plastic Liner



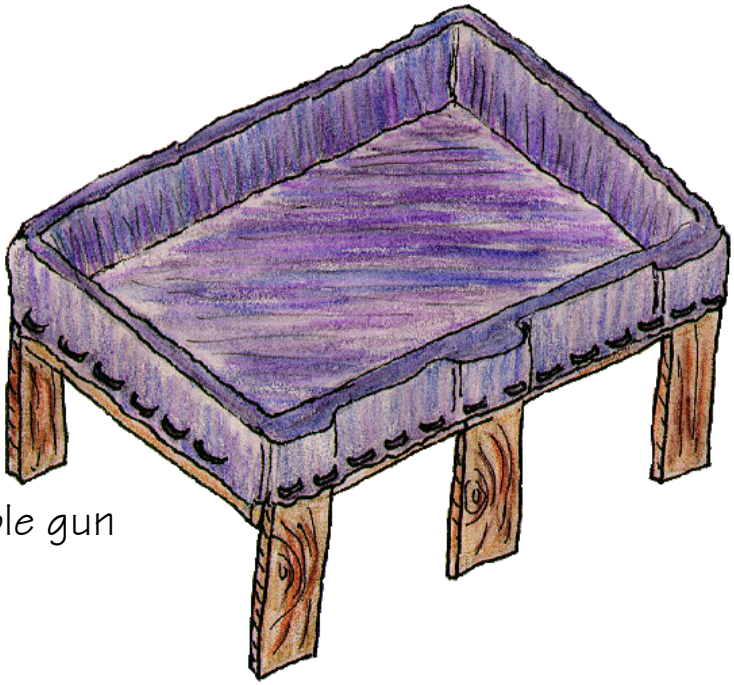
0.10 or 6 ply black plastic sheeting

Black plastic is used to line the bed grower and waterproof the container. Black is used to reduce algae growth and make the root area darker. Make sure the material is waterproof.

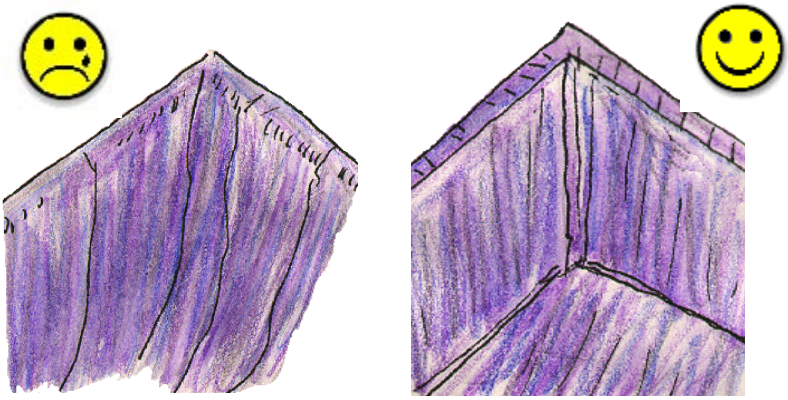


When laying out plastic sweep area or lay down newspaper to protect from punctures and tears.

Waterproof Bed



Place plastic carefully in the bed without puncturing or tearing. Staple overhang to the lower outside of the grower.



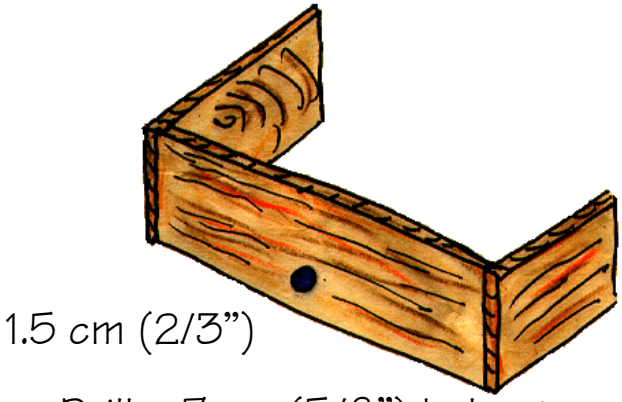
Black plastic should be in perfect contact with the frame and the bottom of the grower.

A media grower of sand is prepared for germinating seeds. The modified soda bottle acts as a watering device.

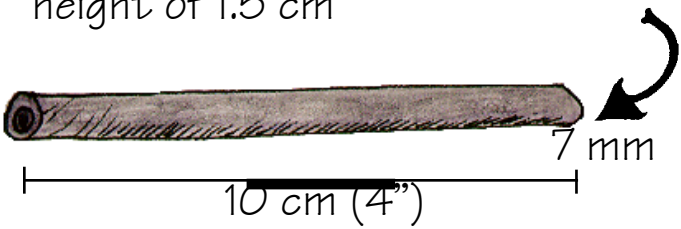
A large garden of media bed growers is planted in lettuce. The large yellow sticky cards are used to prevent white fly attack.

Media Bed Grower

A bed grower is filled with growing media and plants are planted as in soil.

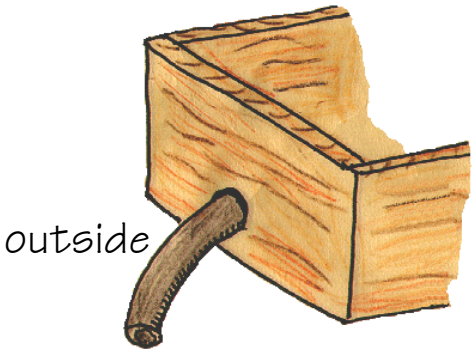


Drill a 7mm (5/8") hole at a height of 1.5 cm

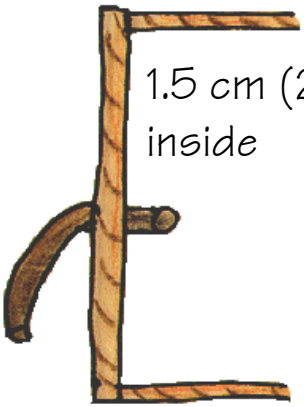


Cut a 10 cm (4") piece of 7mm (5/8") outside diameter black plastic flexible tubing.

7 cm (3") of the tubing should hang outside the grower and not more than 1.5 cm (2/3") should be inside.



7 cm (3") outside for the drain



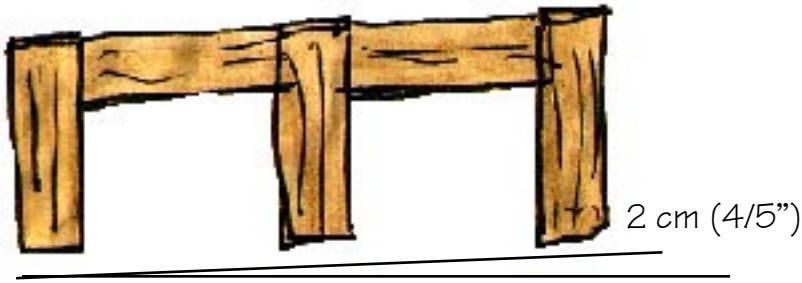
Black plastic liner

Black plastic hose

Heat sealed.

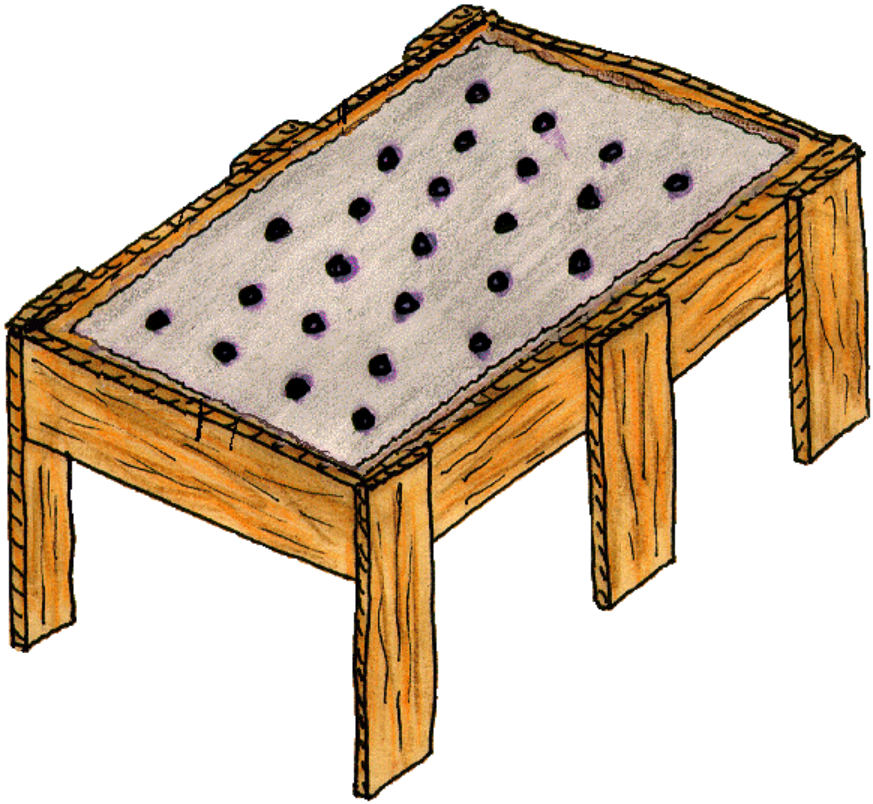
The hose must be sealed to the inside black plastic liner. This is accomplished by heating the area where the hose comes into contact with the black plastic, melting the black plastic around the hose. This is accomplished by heating a hot nail or cigarette. Before using, put wet paper or wet subtrate on the plastic below in case the cigarette ash or the hot nail falls down.

Start filling with growing media by starting at the drainage end, and from there the rest of the grower. This prevents any movement of the plastic and keeps the hose from getting unstuck.

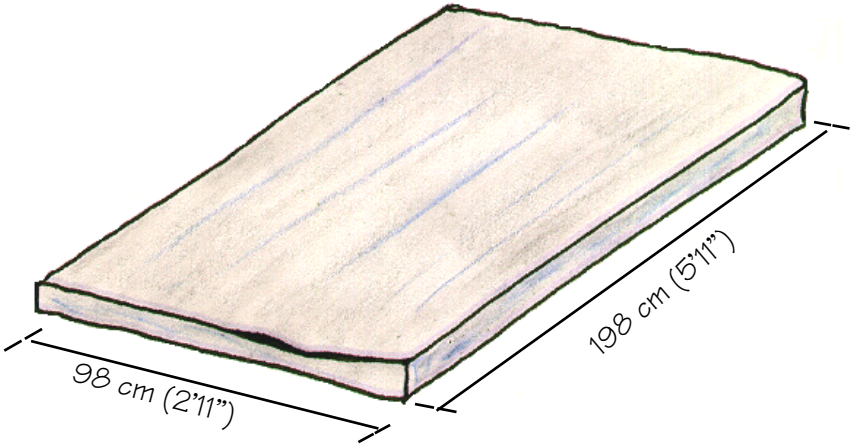


Place bed off ground about .5% (1 cm per meter) (2/5" per 3 feet), so it will drain better.

Floating Bed Grower

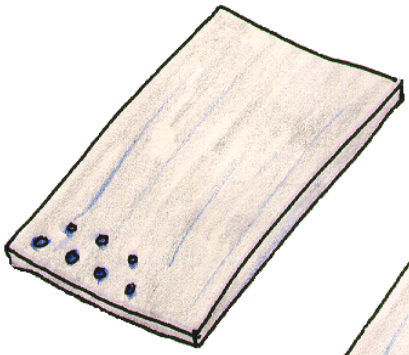


A bed grower filled with nutrient water and a 2.5 cm (1 “) thick sheet of styrofoam is used to support the plants.

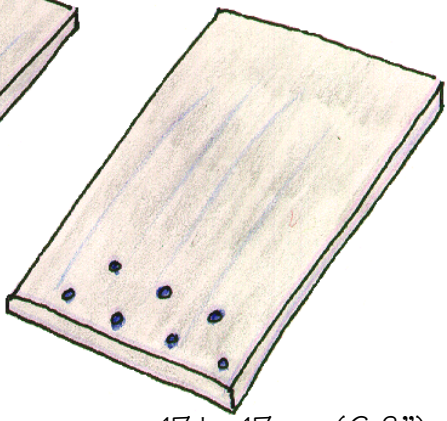


White styrofoam 2.5 cm (1") thick is cut to a length 2 cm smaller than the length and width of the growing bed.

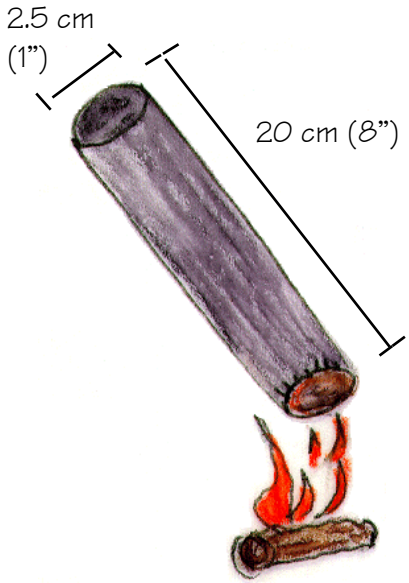
Mark holes for the plants. In lettuce, we use two patterns



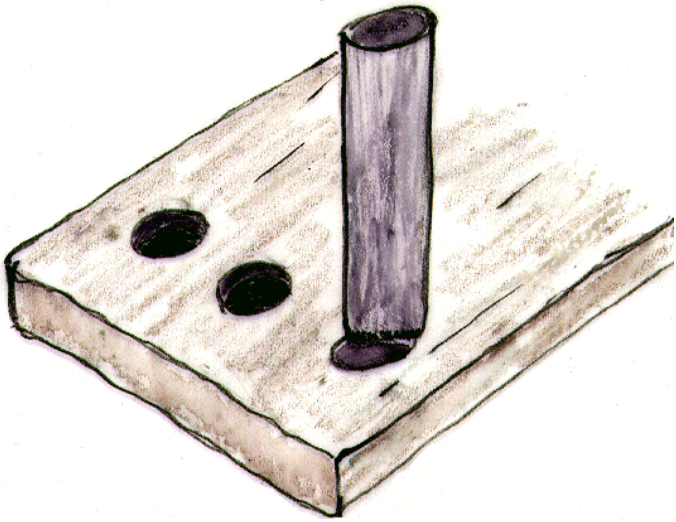
9 by 9 cm (3.6") between plants (126 holes)for 15-20 days after seedling



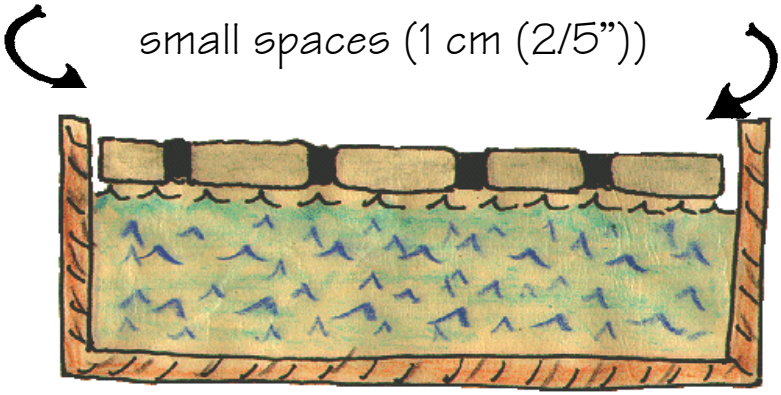
17 by 17 cm (6.8") between plants (31 holes) for 25-35 days to complete fully grown lettuce.



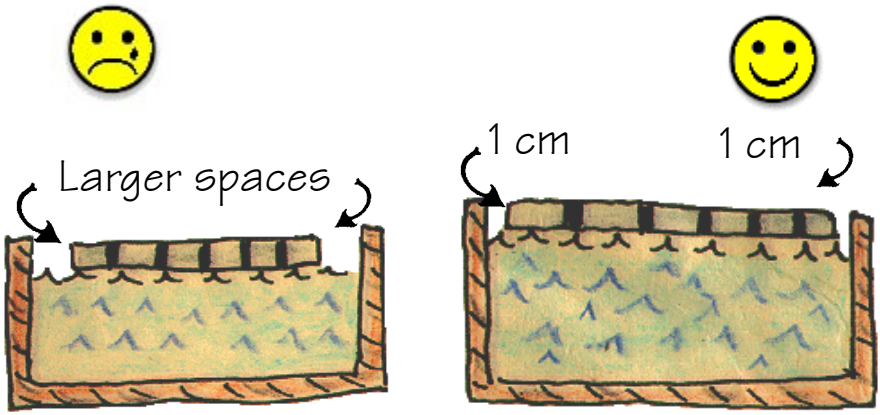
Tool for cutting holes in styrofoam - a 20 cm (8") round or square steel pipe of 2.5 cm (1") diameter. The tool is sharpened at one end.



Press the tool at each point allowing it to melt and cut through the foam. The materials extracted from the pipe leave a perfect round hole in the foam.

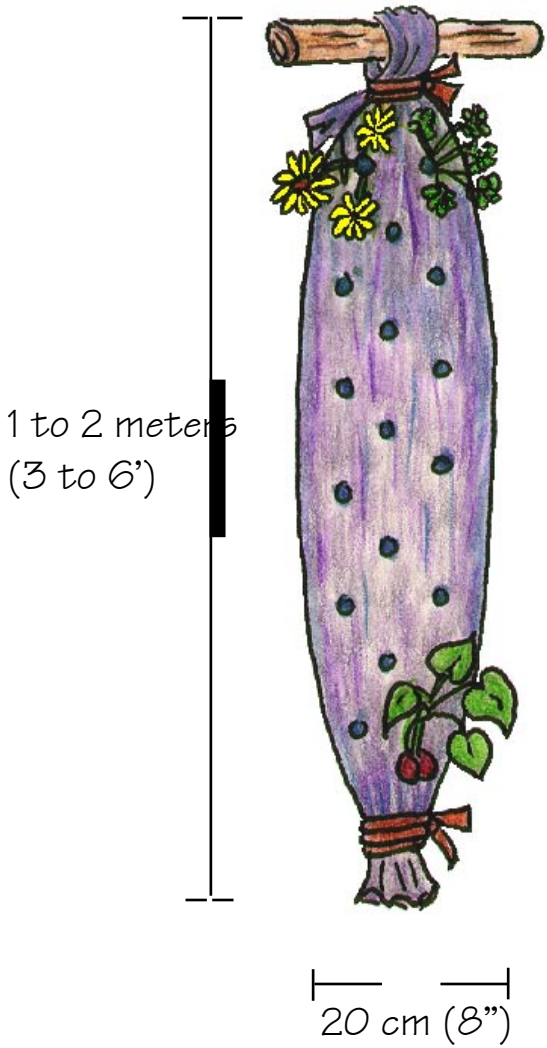


The styrofoam with holes is placed in the bed with enough space to permit slight movement. The bottom of the foam will rest and float on the water.



There should not be too much space between bed and styrofoam. This would cause algae growth and greater loss of water due to evaporation.

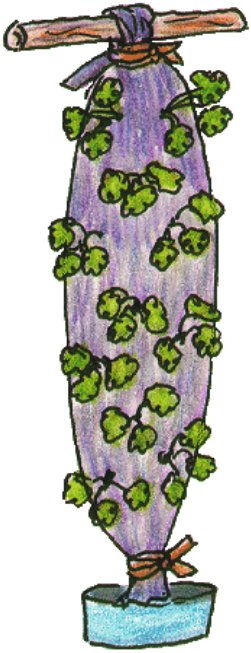
Hanging Sleeves



Hanging sleeves are made of preformed black plastic tubing. They can be cut to any height and are hung or laid on the ground.

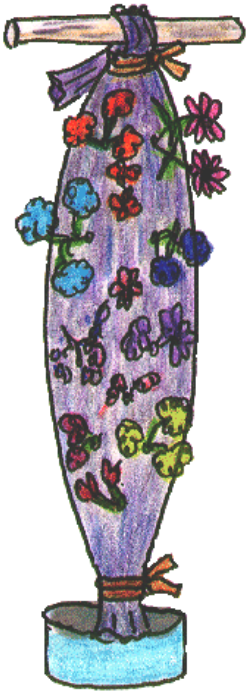
Strawberries

Transplant ed plants are used in hanging growers.

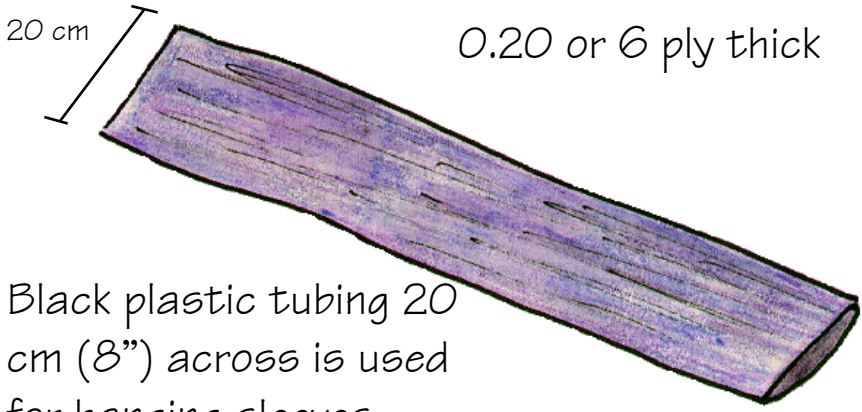


Parsley

Lettuce

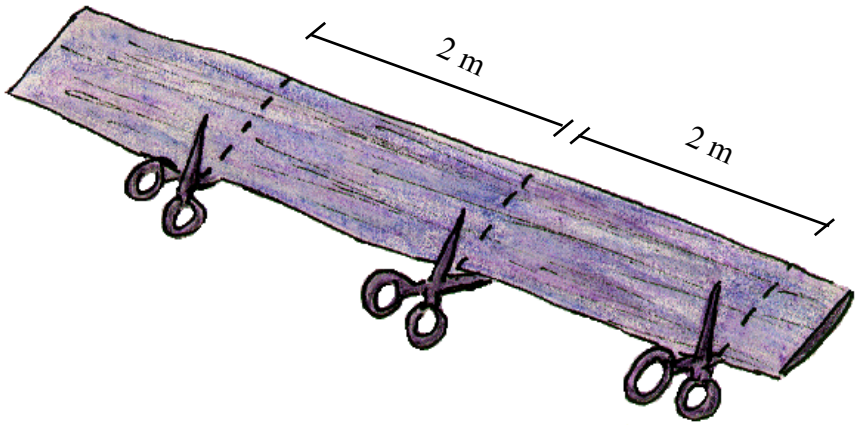


Small Flowering Plants



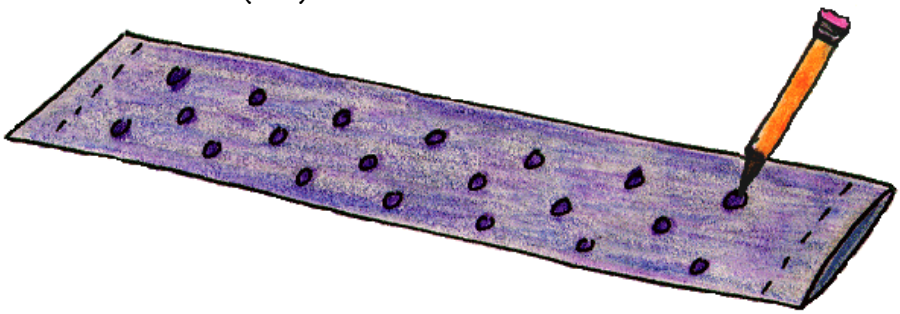
Black plastic tubing 20 cm (8") across is used for hanging sleeves.

Black plastic sleeves come ready made in different widths and thicknesses. A minimum 0.2 thickness is important for the sleeve must support weight of the growing media.

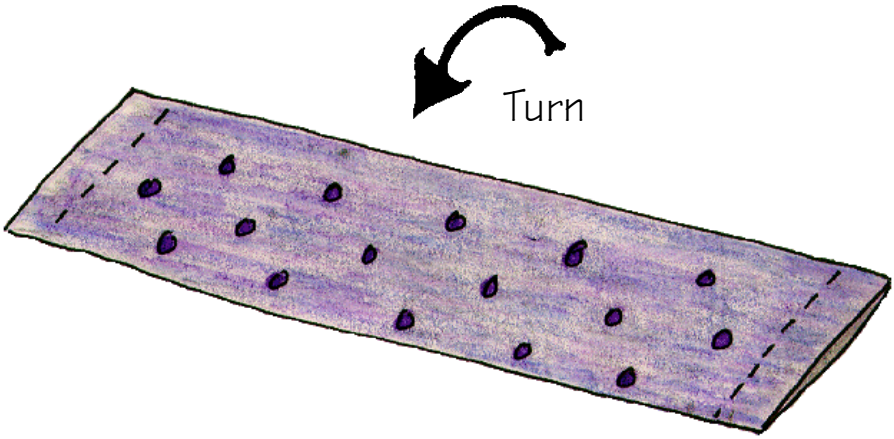


Cut 2 m (6') pieces of sleeve or a length you can handle at the site. Consider the height that is comfortable to irrigate and tend.

12 cm (5”) draw a line on each end

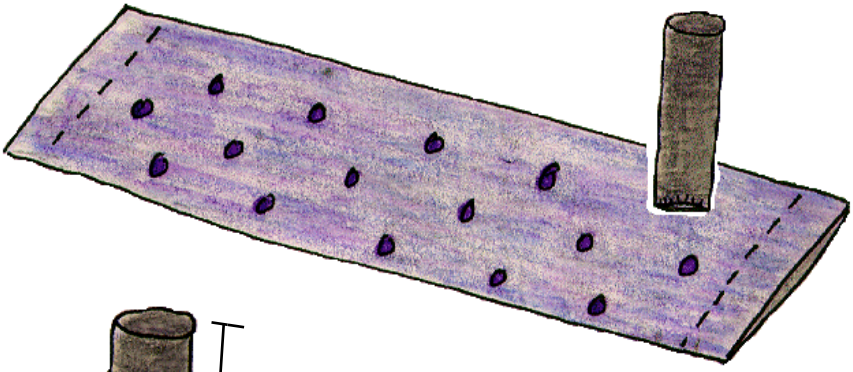


Mark out the places for the holes. Start 2 cm (4/5”) from the line at 12 cm (5”) and make marks for two holes and on the next line make a mark for one hole.



Turn over sleeve and draw the opposite pattern on the second side. (First one hole, then two holes).

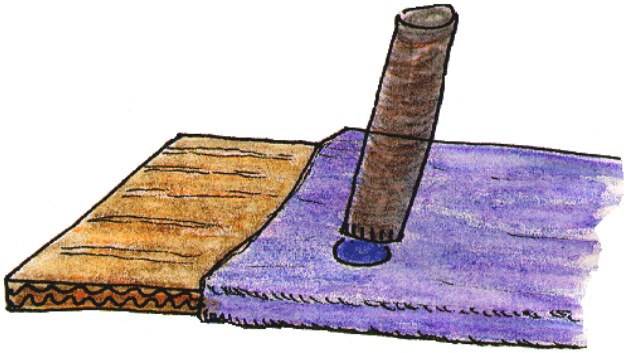
The alternating pattern of holes allows the sleeve to have greater strength than if all holes are placed in a straight line (not alternated).

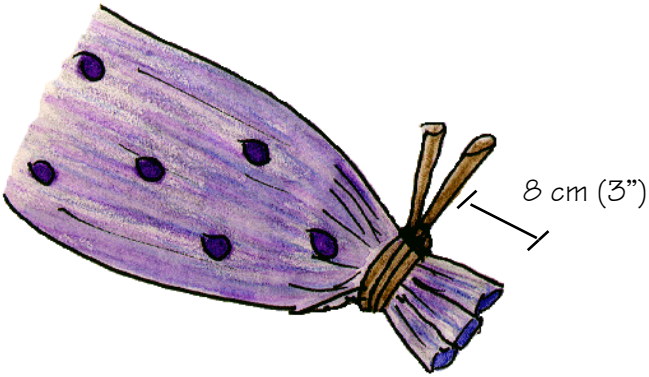


After the sleeve is marked on both sides, cut holes in the plastic.

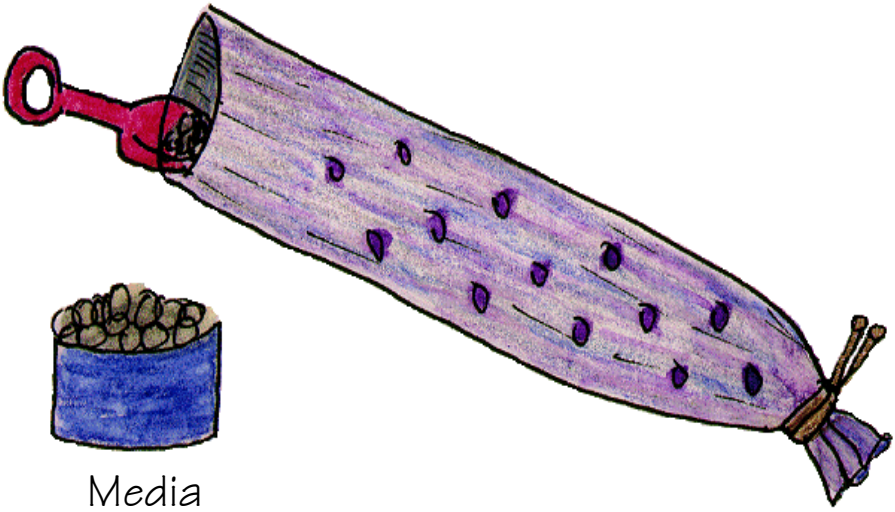
Holes are cut with a metal tube of 2.5 cm (1") diameter.

Before cutting place a piece of cardboard or folded newspaper inside the sleeve. This protects from cutting through to the other side.





Tie the bottom end of the sleeve at 8 cm (3") with a string, thread or nylon fiber. Use several loops to make a tight knot.

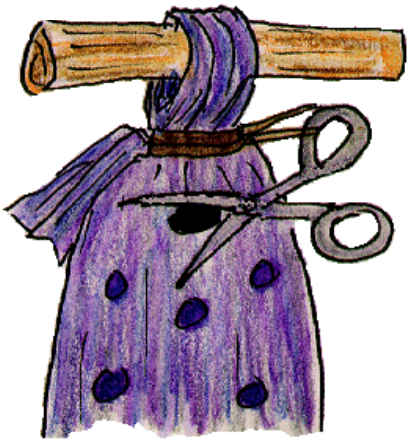


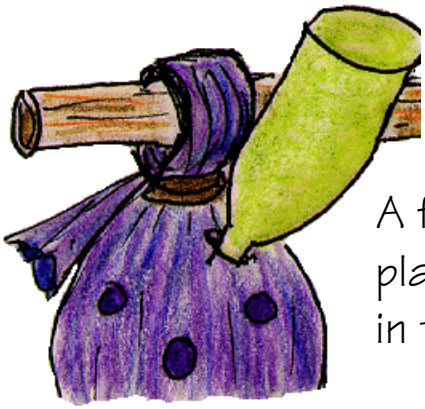
Fill the sleeve with damp growing media. The media should be prepared and dampened the day before. Rice hull takes several hours to become fully dampened. Make sure the media is damp, because after it is in the bag it will not be possible to wet before planting.

After tapping the sleeve gently on the floor to let down media, the sleeve can be hung from a pole.

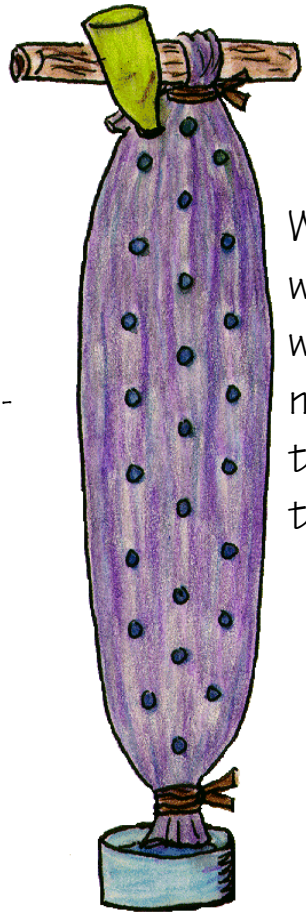
Upper part is tied at 8 cm (3") with string thread or nylon fiber. It is wrapped with several loops and tied tight.

With scissors make a 3 cm (1.25") diameter hole for a watering funnel.





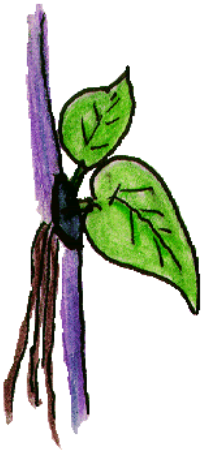
A funnel is cut from a plastic bottle and hung in the hole.



Water two days with nutrient water and allow media to settle. Then plant transplants.

Cut a hole pointing downwards.

Gather water at the bottom.



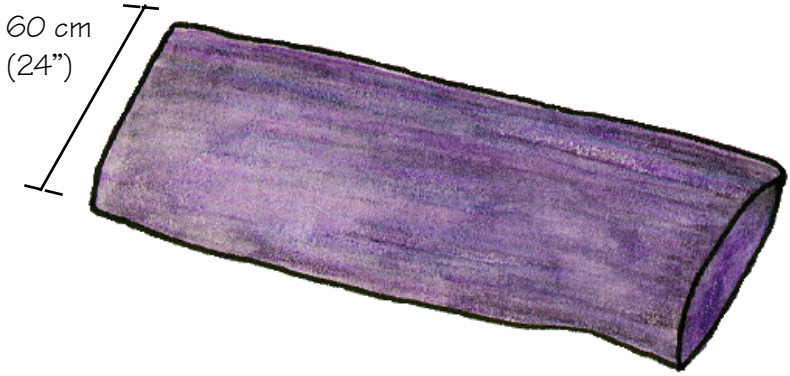
Holes pointing downward are made at each grower hole.

When planting seedlings, roots are introduced with greatcare, so they are not damaged or broken.

Canoe Grower

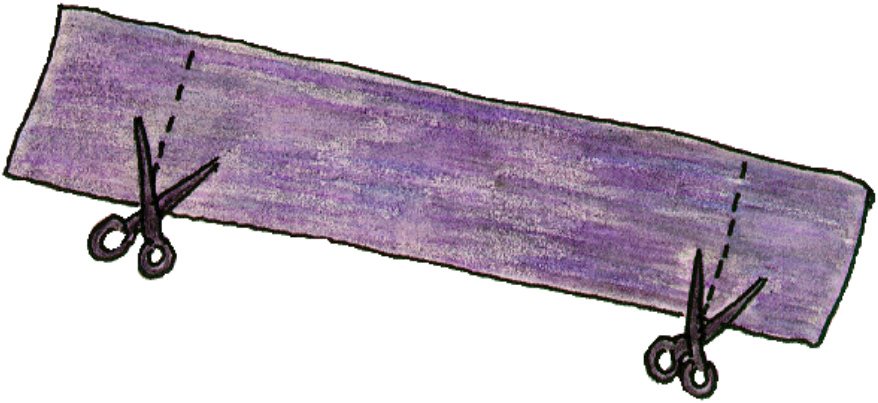
A canoe grower can be hung against a wall or placed at the base of a wall.

Canoe growers are made of 0.15 to 0.20 thick black plastic sleeve 50 or 60 cm (20-24") in diameter.

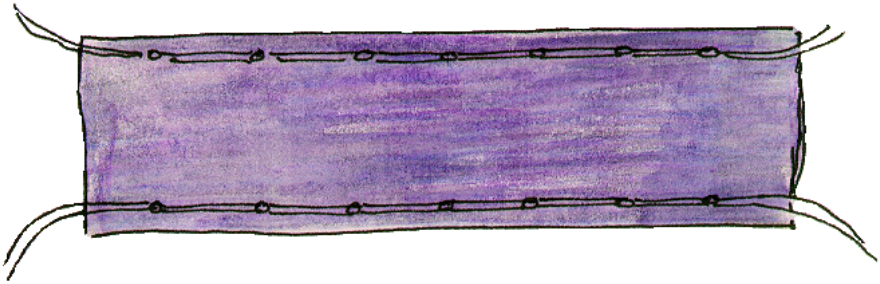


0.15-0.20 thick black plastic sleeve

A canoe can be cut to any length, up to four meters (12') when hung from a wall.

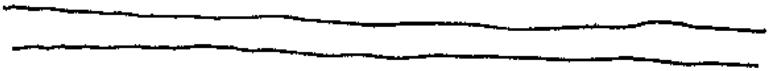


A canoe placed on the floor can be as long as 10 meters (30').

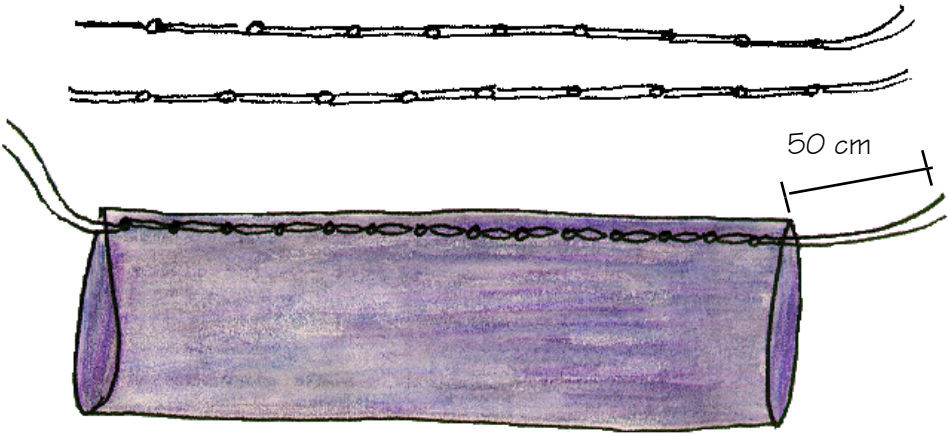


Cut two pieces of string, nylon fiber or thread. They should be twice as long as the canoe plus 2 m (6').

For a four meter long canoe, cut two nine meter lengths of string, thread or fiber.

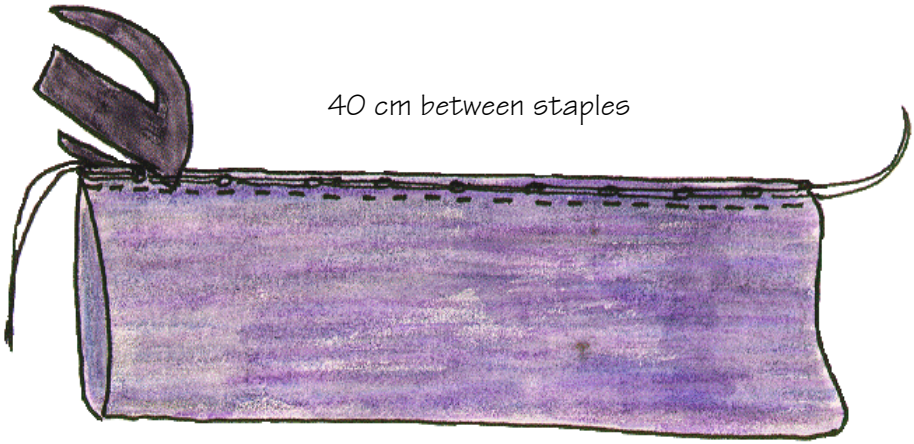


Fold each in two and make knots along the string at every 80 cm.
knots every 80 cm (32”)

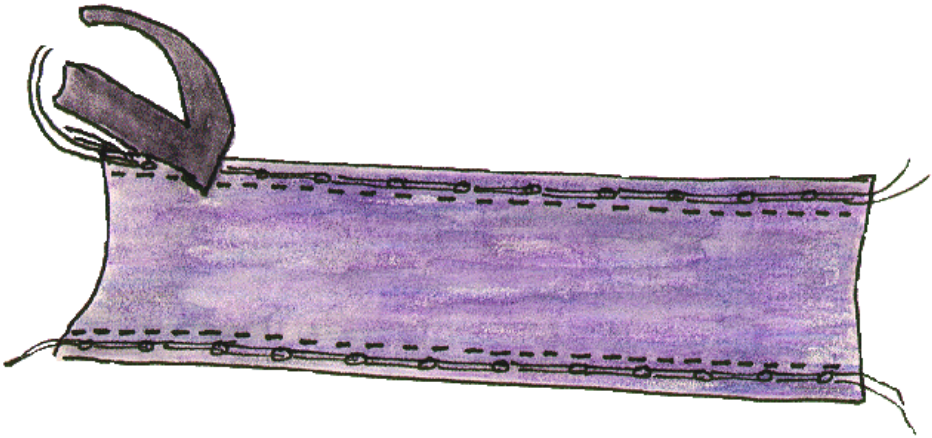


Pull the knotted string through the sleeve to the other side of the grower. Leave a 50 cm (20”) overhang on each side.

With the help of someone else, lift the sleeve by the string and let the sleeve fold rest on the string.

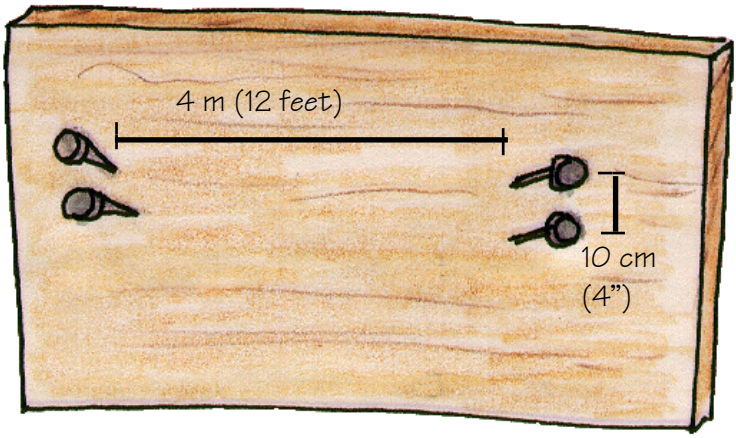


Staple at 1 cm from the fold-edge every 40 cm (16”), or secure plastic string with one or two stitches on nylon thread every 40 cm.

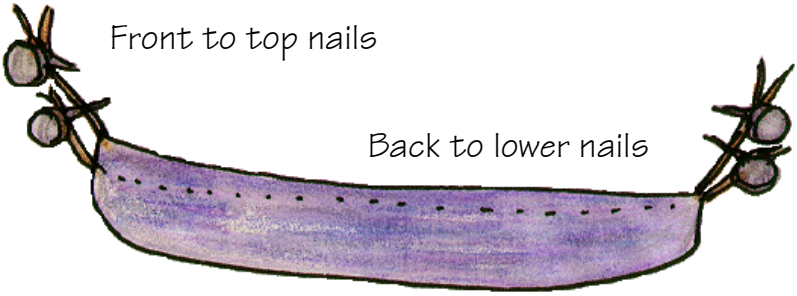


Turn and secure other string to the other side. This will form a sort of hammock.

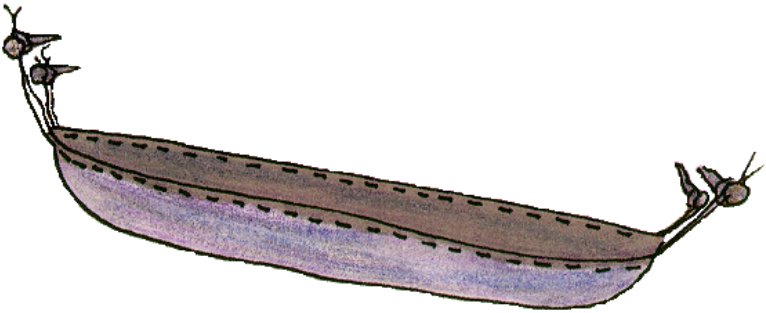
The canoe can be secured to a wall. As many as four canoe growers can be used on a wall.



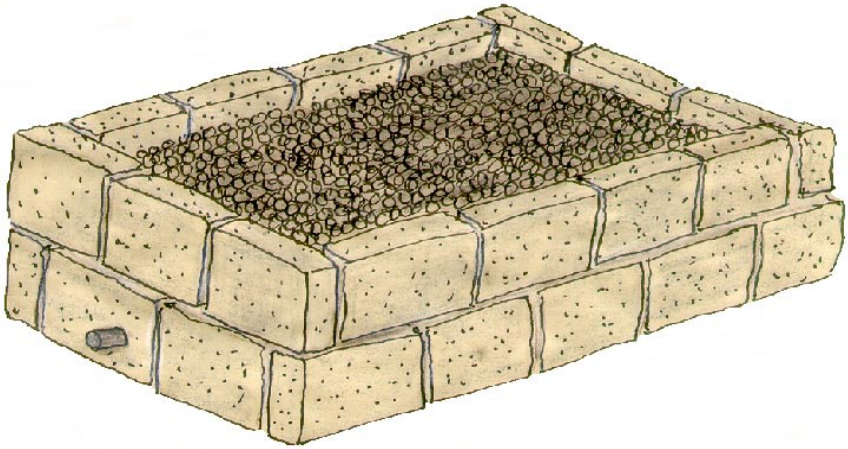
Nail four large (3 ") nails on a wall. Two at a distance 4 m from each other and the other two placed 10 cm (4") below the first two.



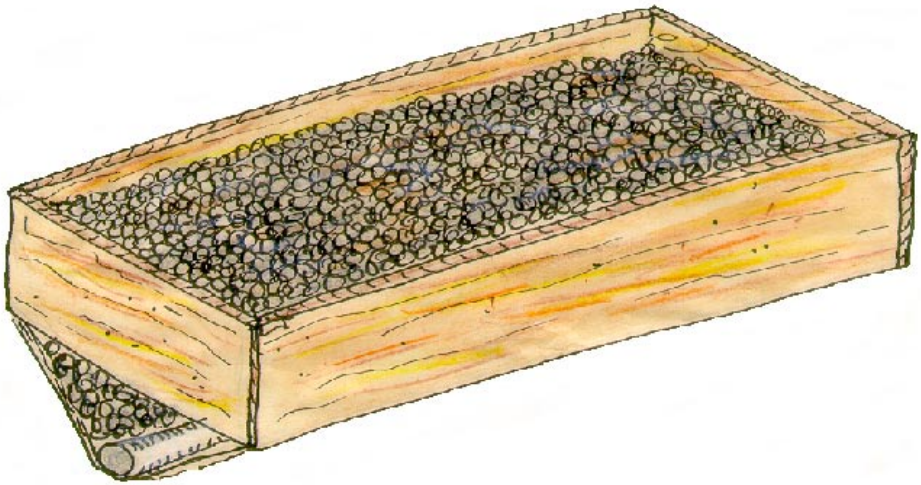
The sleeve is fixed on the wall, drawing string or nylon thread very tight to keep it from bowing down when filled with media.



Hanging bag hydroponic growers are used for transplanted plants such as lettuce and spinach.



An above ground trough grower can be built of cement, wood or adobe blocks. A drain-hole is provided near the bottom.



An above ground trough grower can also be partially above ground and partially below. This allows for less expense in construction.

Trough Growers

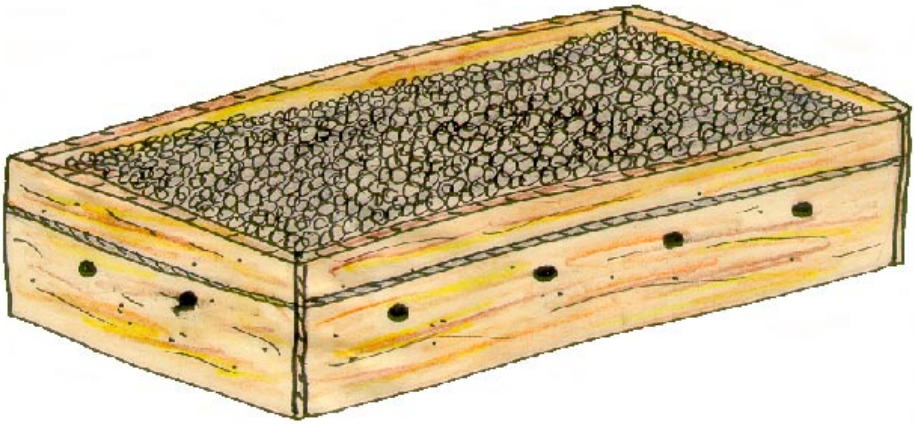
The first hydroponic growers, built by W. F. Gericke in 1936, were called trough growers or basin growers. A trough grower is usually built on the floor or the ground and requires no table support. Trough growers can be built of wood, concrete, adobe mud or mixtures of materials.

Trough growers consist of a wall type container, and a standing bed of nutrient water. They can be built to have a water reservoir below, or a drain hole for daily watering or recycling water.

Troughs can be a problem for insect attack, or even slugs because there is often no physical barrier, no legs to wrap with sticky tape. They can have reduced growth compared to bed growers due to lower air circulation.

Trough growers have many advantages. They can be made of excavated earth, thus often require no money at all, just labor.

Troughs can be made of concrete or cement and incorporated into the landscape or architecture. A deep water container can reduce watering to a once a week or once a month chore.



Hydroponic grower constructed by Gericke in 1930's.

Terraces of growing beds at Machu Pichua. Six months of rain water can be stored in terraces for dry season.

If trough containers are also left outside they can function as cisterns to hold a water supply. They could be made deep enough to hold seasonal rains as a reserve for a dry season.

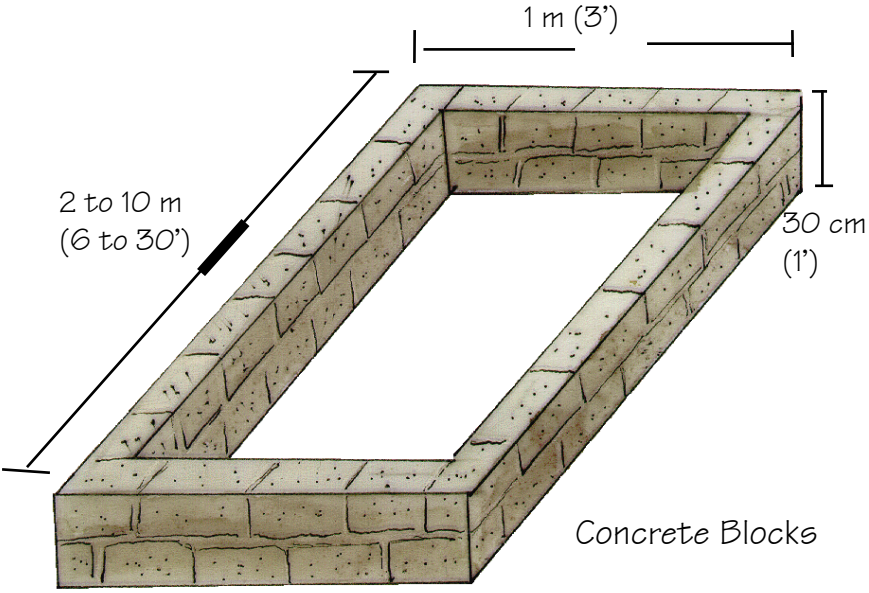
The terraces at the ancient Inca community of Machu Pichua average about 8 foot high. These terraces were used to grow food and may have been used to conserve or hold water.

The climate in that area has a six month rainy season and a six month dry season. To grow crops through the dry season a water storage is necessary.

Gericke's original basins had a six inch deep water basin. The water level was filled to six inches deep and allowed to drop to three inches deep before refilling. This volume of nutrient water would last a month.

When a water basin is used, drain holes are placed above the water line to supply fresh air to the roots. Most root growth occurs in the moisture area between water basin and supporting media above.

Making a Trough Grower



Trough growers are usually built on the ground, and are made of a variety of materials.

They can be made permanent or temporary. For example, walls of concrete blocks can be mortered together with cement, or just stacked together and used with a black plastic liner.

Materials

Mud or Adobe

Trough growers can be built of mud or adobe, and so they can be produced from the earth. There are several methods of construction and many recipes for Adobe.

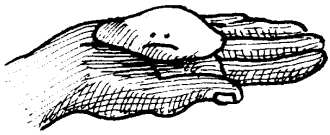
Recipe for adobe

Adobe is the name given to a material used for homes and construction that is made of earth, straw and occasionally some horse or cow manure. It is made of sand, clay soil, water and 1% straw.

Adobe is formed from the correct mixture of silt clay and sand in a soil. The soil should be free of organic material, or humus. It should be about 30% clay and about 70% sand. This should be the mineral soil underneath the topsoil of humus.

The Drop Test

TOO MUCH SAND



TOO MUCH CLAY
OR TOO MUCH WATER

JUST RIGHT!

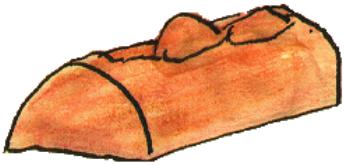
Adobe Drop Test

Make the soil into a ball and add enough water to make the soil in a ball about the thickness of pie crust. Drop the ball from one hand to the other (about 1 meter or a 3 foot drop). If the ball slumps down, it has too much clay or water. If it breaks, there is too much sand. If it holds it's shape it is just right (Smith, 1998).

2. The snake roll test - The good adobe mix will form

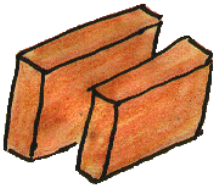
Methods of Construction

Cob

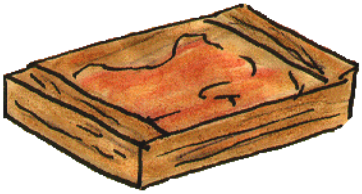


Adobe is mixed with water until it reaches the consistancy of pie dough. In cob construction, handfuls of mud are added to a wall until it reaches a height desired. Usually, no form is used.

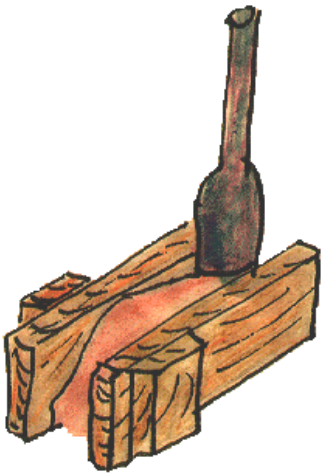
Adobe Brick
Rammed Earth



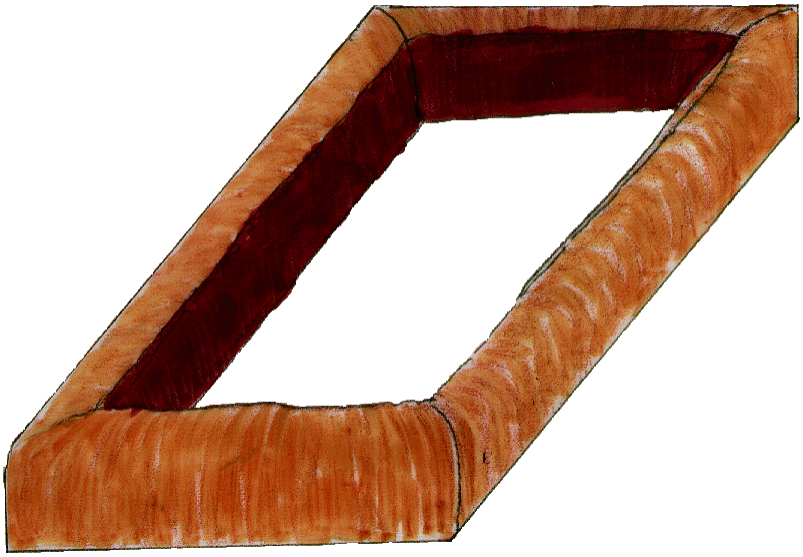
Adobe bricks follow the basic recipe for cob, but the mixture is made slightly drier. The adobe is formed into bricks, using a brick mold. After setting up in the sun for about an hour the bricks are removed from the mold and stacked and left to dry. Hydroponic growers are built of the bricks just like cement blocks.



Rammed earth uses the same recipe for adobe, but sometimes also adds 10% portland cement as a stabilizer.
Rammed earth uses a form, with mud poured into form. The mud is tapped or rammed in as the form is filled.
If there are a large number of trough growers to be built, rammed earth is a very good choice.

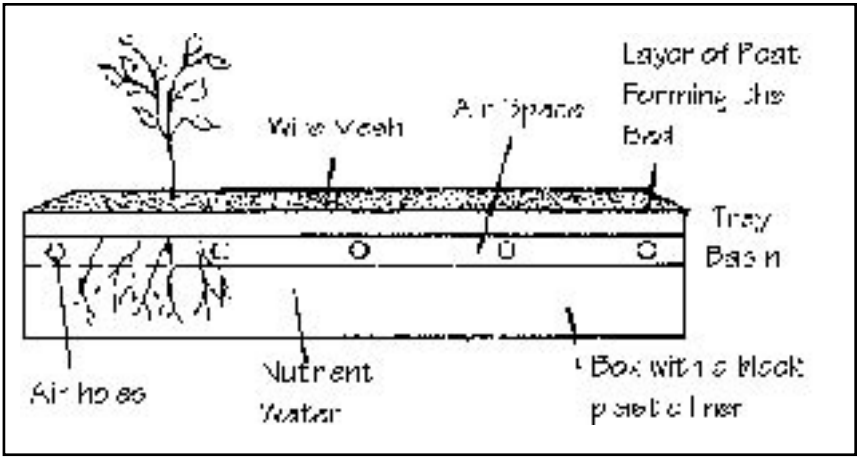


Trough Construction

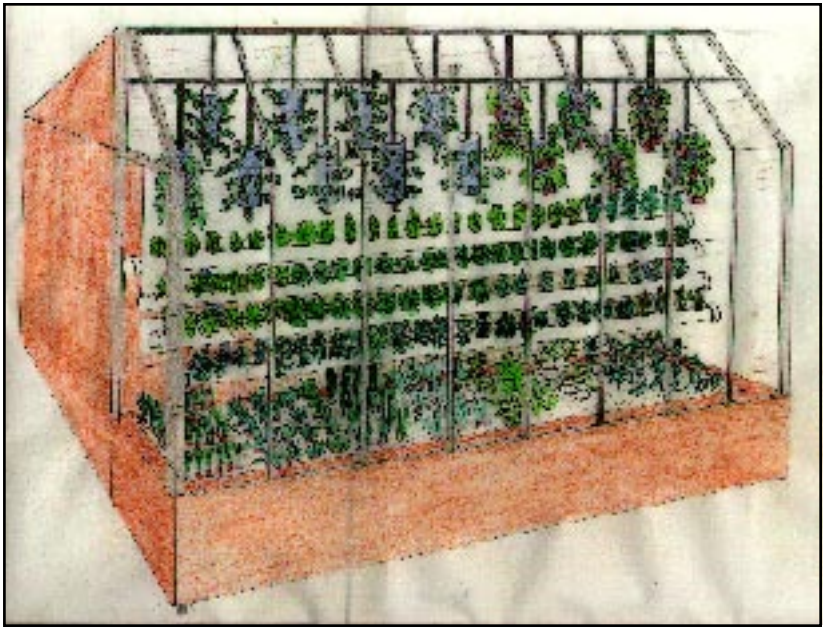


The first step in building a trough grower is to find a place with level ground protected from standing water in heavy rains.

Adobe or earth materials must be protected from rain or they will slowly dissolve. This can be accomplished by wrapping the finished grower in black plastic to protect from moisture on the sides.



Gerieke's original trough growers would include a month's supply of nutrients and nutrient water.



A small shelter can include a hydroponic garden.

Trough growers can be very creative, and do not have to be made in rectangles. They should be at least 30 cm (12") Deep to allow for tall plants and root plants. Where the drainhole is placed will determine how many days water it can hold.

Hydroponic Homeless Shelter

A residential street in Armenia, Colombia after the January, 1999 earthquake. The homes on this street were reduced to rubble.

In January, 1999, a 6.0 earthquake struck the town of Armenia, Colombia in the heart of the famous coffee growing regions of South America. The earthquake left 50,000 families without homes. Even with over 45 million dollars in relief money, one year later, almost all were still homeless, still dependent upon these agencies for their daily food.

The shelter that has been provided are large wood frame buildings with rooms divided by sheets of black plastic. In many cases, hundreds of people live in these buildings with dozens sharing the black plastic cubicles.

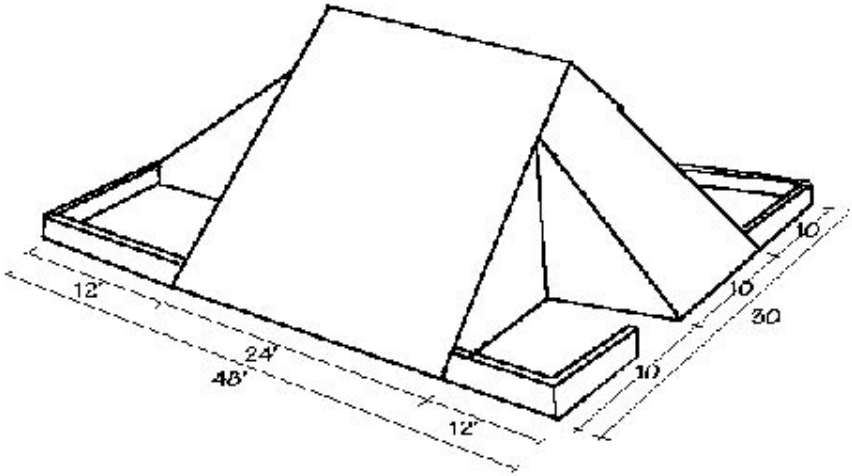
Cesar Marulanda went to Armenia in response to family needs. His mother, an Armenia resident, was one of those many people who, in a single moment, lost their homes and everything they owned.

Cesar got in touch with Peggy Bradley about conditions and urgent needs, they started working

together with a group called Carbon Quest, to set up a project in Armenia. They began teaching home hydroponics to the people so they could start their own gardens. With this in mind, Peggy set out to design a homeless shelter for the people, that would use hydroponics for growing food, storing rainwater and treating household wastewaters.

The design of the shelter is a basic 30 by 48 plastic covered greenhouse, similar to that we use commercially in the nursery and hydroponic industry. The frame could be either a modified A-frame, or a quonset hut style of frame.

Armenia, Colombia is very close to the equator (4°N) and daylength is about 12 hours a day year round. This means that the sunlight resources of the

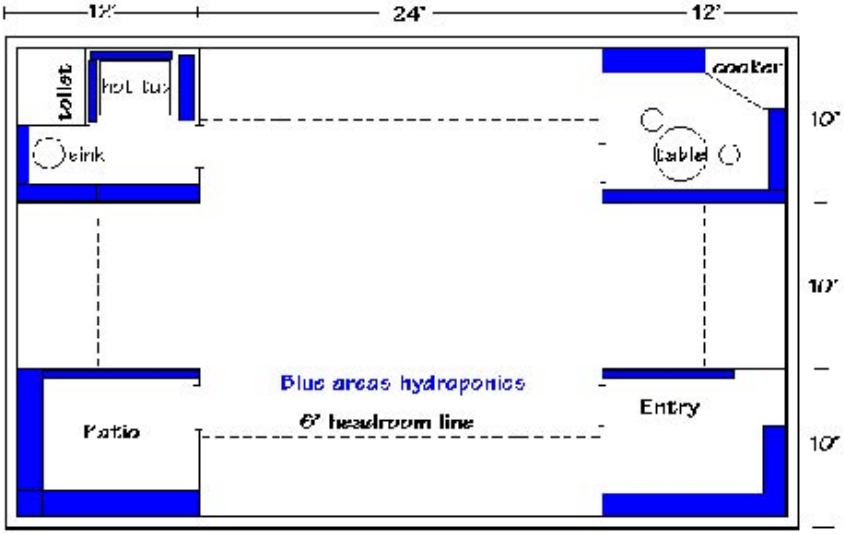


The homeless shelter is a plastic covered greenhouse structure, 30 by 48 feet. Each corner is folded back to allow for four outdoor patios.

area are sufficient to grow food yearround. Because the region is in a mountainous area it enjoys even temperatures of 65 to 75°F year round, again ideal for raising plants. Water resources are also plentiful, with an average of 8 inches of rain falling each month.

So a opaque plastic covered greenhouse of 48 by 30 foot would provide private family space indoors and a covered growing space for producing hydroponic vegetables. Cesar Marulanda's work had

already established that a space of 40 square meters could supply a family with nearly all its fresh food needs, and perhaps 25% of the necessary food calories



The shelter has four outside patios that incorporate hydroponic growers. The growers are deep troughs to store rainfall.

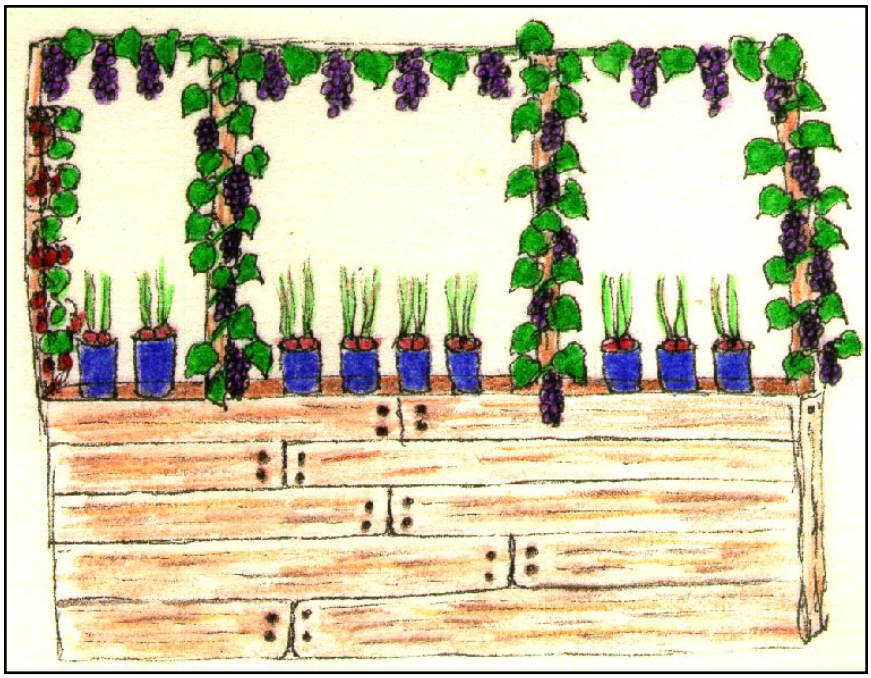
for the family.

Cesar places his hydroponic gardens outdoors. There is a long standing problem in "greenhouse living" in that a plant filled space can rapidly become too humid for human comfort. Knowing this, Peggy placed an outside patio in each of the four corners of the shelter. These became spaces for growing hydroponic food, and for dividing some necessary spaces.

Front patio –

The first growing space is the front patio, also used as a front porch. This was modeled after shelter housing located in Manila. In the northern part of the city, after World War II, many of the cities poor built shelters out of any available waste products.

Now, 50 years later, there are wonderful spaces where

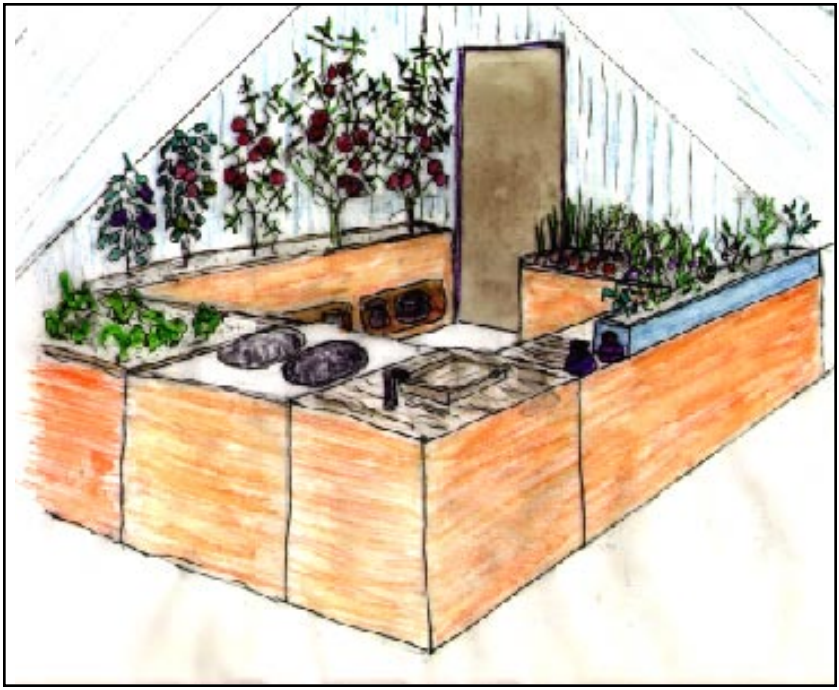


Front porch area boasts grapes, and a variety of snack foods and fruits.

people look out to the street behind spaces surrounded in greenery, looking like scenes from enchanted fairytales. Passing by shelters in the evening, people are found in the outdoor porch areas laughing and talking to neighbors. Because of the friendliness of the area the Armenia shelter started with a front porch that will some day be wrapped in vines and greenery, a completely livable space.

The front patio is surrounded with simplified hydroponic bed growers. The two against the greenhouse walls are planted in vine crops that offer some interior shade and privacy. The space could be quickly covered in beans, melons, tomatoes, cucumber, or peas. The front and side of the patio have knee high bed growers planted in a variety of root crops for daily food.

The kitchen patio offered several challenges,



The kitchen patio includes a solar cooker and warm water. Several hydroponic growers provides cuilinary herbs, salad vegetables and other fresh foods.

and then an opportunity to build a solar cooker. An international wedsite was set up to design the cooker. The web based design team started working on a cooker that could be made from rubble. Within a week there was a volunteer design team working on the cooker. The solar cooker allows for food to be cooked using solar energy, with a backup barbeque when the sun does not shine.

In the kitchen area, culinary herbs are grown along with more root crops, and all salad vegetables. The kitchen area grows most of the salad vegetables out of bed growers, spaced around the wall. So fresh food for the family dinner is only a step away from the cooker.

Wash water is provided by a rainwater cistern that stores water and allows for both water pressure and for solar heated warm water. Dish wash water is

The bathroom patio has a hot tub, and a outhouse area which houses a hydroponic composting toilet.

recycled into the worm farm which acts as a garbage disposal, getting rid of all household food and garden waste. The worm castings from the worm farm provide a bloom nutrient for the tomatoes, green peppers and fruits.

There is a back private patio that can be used as a family area. It grows more food, probably soybeans for a extra staple foods.

The fourth patio is a bathroom area and offers the greatest opportunity to meet real challenges with hydroponic technology. A hot tub offers a space to cistern water and use solar energy for heat. The water in the hot tub is constantly being recycled through a water filter of freshwater mussels that can take out diseases. The water also goes through a hydroponic of flowers that surround the hot tub and provide another privacy wall.

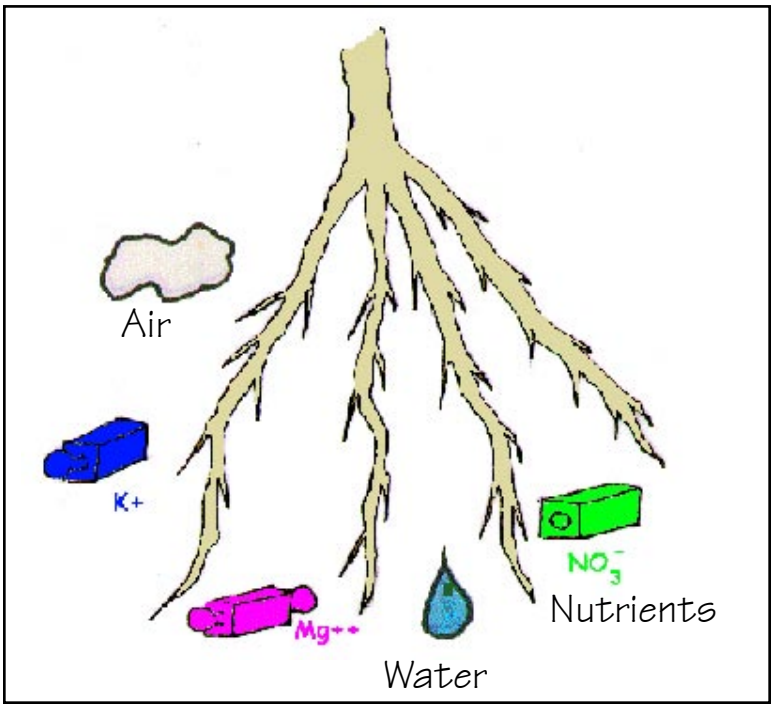
The hydroponic composting toilet uses both composting processes and a flower wall of hydroponics to completely utilize the daily human wastes.

Jose and Maria mix a growing media for their grower. They are using rice hulls and sand.

5. Growing Media

In soil, a plant's roots grow downward or outward seeking water and nutrients. In hydroponics, plants are grown in a growing media that replaces soil.

One of the reasons hydroponic plants usually grow faster than soil plants is growing media designed to give roots ideal growing conditions. This is having water, nutrients and fresh air available in the root area.



A hydroponic grow media is something that will hold both water and air for the plants. There is no special type of growing media that is necessary for success. Many types of growing media have been used for hydroponics and there may be more yet to be tried. Media is often selected for special crops or environmental conditions. Some media is a natural product you can gather or something that can be purchased nearby.

Common Growing Media

Perlite - a volcanic rock of gray obsidian, that has been heated to 1200˚F in a kiln and expanded. Perlite is a lightweight porous material that wicks (draws) water from the bottom of the container.

Ceramic grow rock - a clay material also called Geolite, often used for aquaculture because of the porous material. Geolite is a good media for growing bacteria for organic hydroponics.

Rockwool - a material made from rock spun into a fiber like material. A phenol-based resin is added as a binder. Rockwool can increase the pH of the water.

Pea gravel - this media is a common gravel that has been graded for size and shape. Pea gravel is not a porous media so it does not draw water from below and is commonly used in an aerated system. It can be used to grow bacteria as well as plants.

Sand - many sands, such as beach sand, have salts in the media that can cause problems in hydroponics. Sand is a useful media that retains water and should be sterilized between plantings.

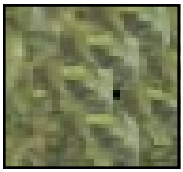
Sawdust -species is important. Avoid sawdust from red woods and pinnus or connifera family. Sawdust from logs soaked in salt water may be toxic to plants. Quantities more than 20 % sawdust cause poor growth and 10 % sawdust can increase humidity retention, specially in the dry period.

Peat - Peat is very acid and can lower the pH of the nutrient solution. It breaks down after one or two growing seasons and can be expensive.

Vermiculite - This is a volcanic mica, which has been popped in a kiln. It is a magnesium aluminum iron silicon material that can be compressed and lose its porosity. It may contain asbestos fibers.

Pumice - A silicon material of volcanic origin can break down after repeated use. It is a natural material that is very effective may be available locally.

No media - Many hydroponic systems use no media whatsoever. The plant is usually started in a small piece of rockwool, or a Growing Cube. The plant is placed in a growing tube or container with water directly on the roots.



Rice hulls - The waste product of rice production and is often available in agricultural areas. It is a light weight material that absorbs water. Rice hulls decompose slowly, and are low in cost. It has good drainage, high aeration, low retention of humidity. Rice hulls are often mixed with another media.

For use in hydroponics, rice hulls must be kept wet for one week prior to use. It is an excellent organic substrate but must be mixed with other organic and inorganic substrates.

Bed growers using a rice hull mix growing media.

Mixed Media

All the growing media can be used alone, or a growing media can be made from mixing two or more types. In developing nations, the following mixtures have been tried with success for over 30 plant species.

50% rice hull with 50% coal materials
80% rice hull with 20% sawdust
60% rice hull with 40% river sand
60% rice hull with 40% volcanic materials
(Any mixture may be reduced 10% in rice hulls and adding 10% sawdust to improve water retention.)

When coal scoria, volcanic tufa or river sand are used, the materials should be washed four or five times to eliminate all small floating particles. The substrate is ready when the water from washing comes out clear. If large amounts of substrate are needed, sieves or screens may be used during washing to retain particles larger than 2mm. Particles over 7 mm should also be excluded.

The material is washed to remove any acid or base. If the pH does not reach neutrality (6.5-7.0) through washing don't use the material.

The center grower uses a mixed media of sand and rice hulls..

A Good Growing Media

1. Particles are bigger than 2 mm and smaller than 7 mm. Excess particles of sizes below .5mm make drainage of surplus water slow and limit root airing. Larger sizes keep smaller seed from germinating, limits humidity retention and can cause strange shapes in tuber vegetables.

2. It should retain humidity and allow for runoff of excess water from watering and rain.

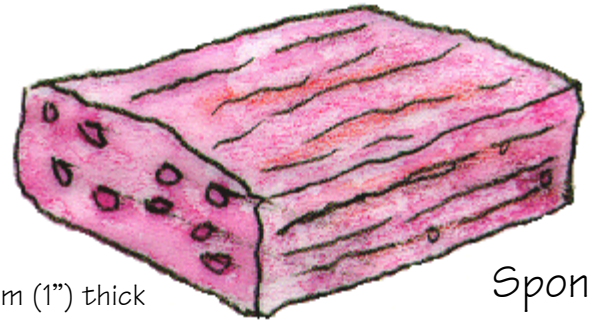
3. It should not retain a lot of humidity at the surface. The surface should be dry to reduce evaporation moisture loss. This helps to avoid diseases which appear when high temperature and high humidity exist at the same time for long periods, especially at the end of the day.

4. It should not decompose or degrade easily.

5. It should not contain microorganisms harmful to human or plant health.

6. It should not have excess nutrients that would confuse the hydroponics.

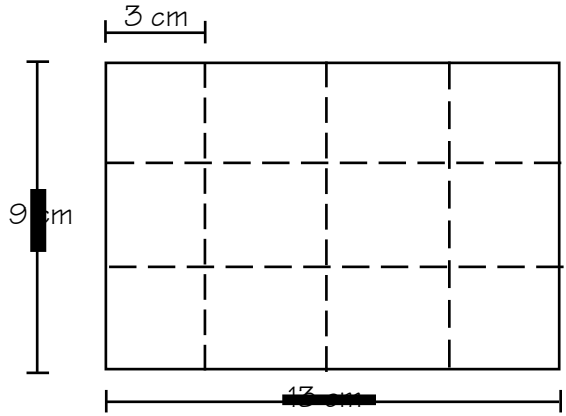
Growing Cubes



2.5 cm (1") thick

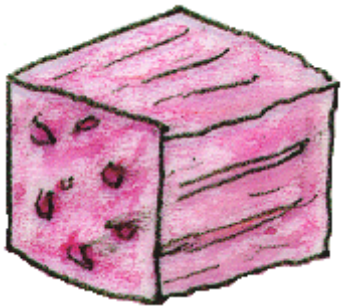
Sponge

To make plant holders for lettuce in a floating bed, cut a household cellulose sponge into smaller pieces. Also used for celery, basil, water cress, and mint.



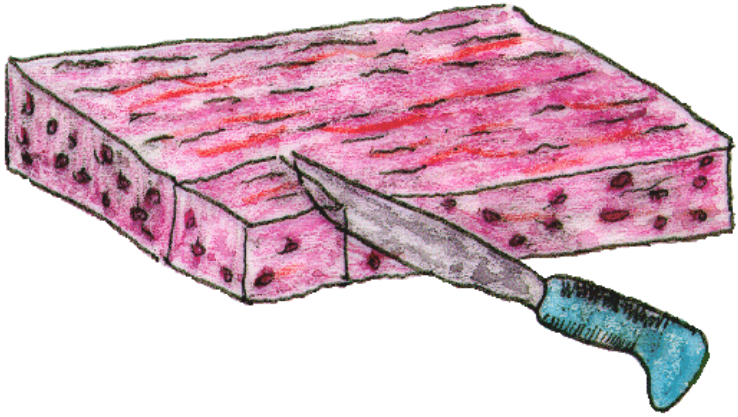
Sponge top
Sponge size can vary

Layout and mark the sponge into 3 cm by 3 cm (1.25") squares.

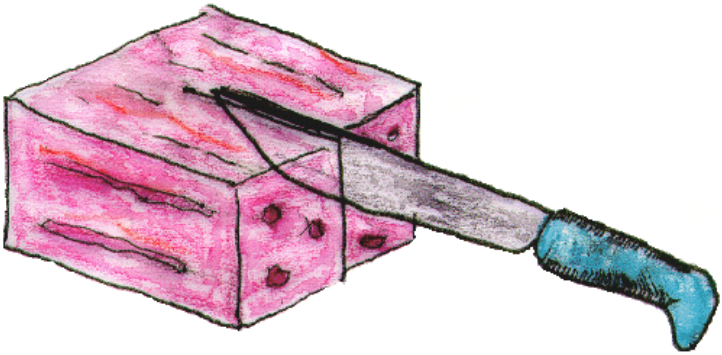


Cubes for holding small seedlings

Cutting Growing Cubes



The cubes are cut with a well sharpened knife, without using too much pressure that could deform the cube.



A vertical slash is made in each cube from top to bottom. The seedling will be placed in this slash.

Jose is adding dry hydroponic nutrients to the water supply. Maria will then water the plants with hydroponic water from her sprinkler bottle.

6. Plant Nutrients

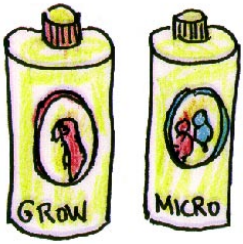
In hydroponics, plants receive their food from the nutrients added to the water supply. As the plants are watered, they receive their daily supply of water and necessary mineral nutrients.

The hydroponic nutrient includes 13 mineral foods the plant requires. There are commercial hydroponic nutrients offered in both liquid and dry forms. All of these must supply all 13 minerals in special forms the plant can use.

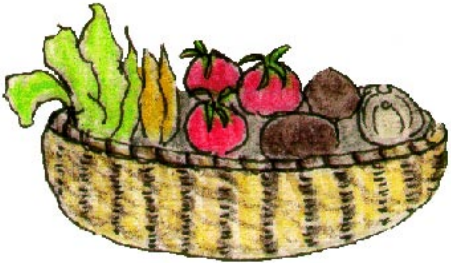
Most of the plant is made up of water and elements it obtains from the air, so the minerals supplied by hydroponics is a very small part of the plant. A small amount of nutrient will produce a lot of plant material. One pound of dry hydroponic nutrient can supply at least 150 pounds of wet or fresh plant material.

Inorganic nutrients are made from mined materials and are purchased. They usually include a two or three part formula.

Just one pound of hydroponic nutrients



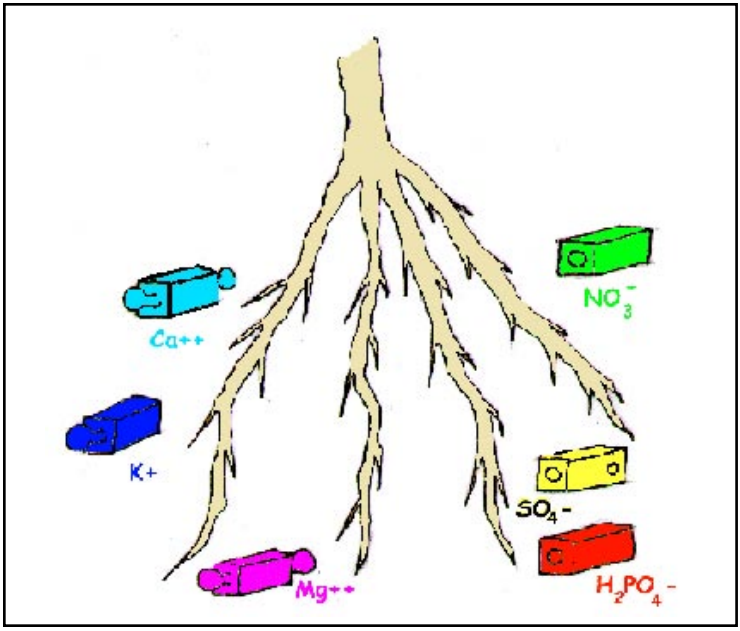
or 85 ounces of liquid nutrients



can produce at least 150 pounds of fresh vegetables.

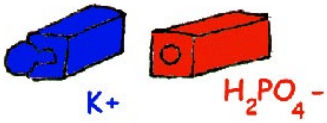
What's in hydroponic nutrient?

The nutrient is made up of Macro and Micro nutrients. These are purchased in powdered form, measured carefully and added to the water.

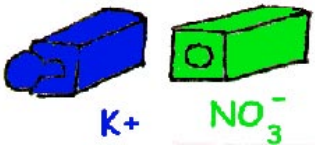


Of the 13 mineral nutrients, six are needed in larger quantities and are called macro nutrients. The macronutrients usually supplied by three different salts. For example, magnesium and sulfate are supplied by magnesium sulfate or Epsom salts.

Magnesium sulfate or Epsom salts supplies magnesium and sulfur for the plant.



Potassium phosphate supplies potassium and phosphorus.

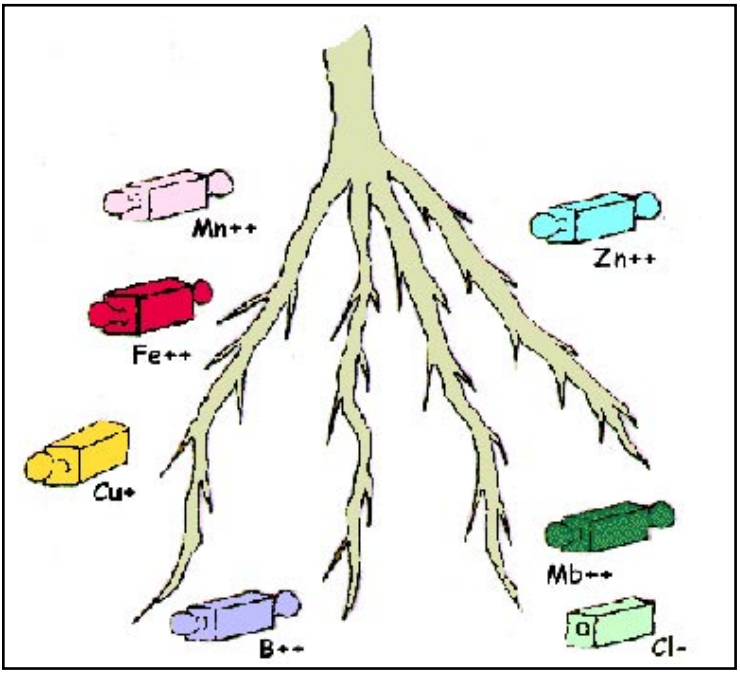


Potassium nitrate supplies potassium and nitrate nitrogen.

Micro Nutrients

Seven micronutrients required for growing plants are needed in very small quantities. Micronutrients are necessary but if too much is used, the plants may die. They require careful measurement and a scale that can accurately measure 0.01 grams.

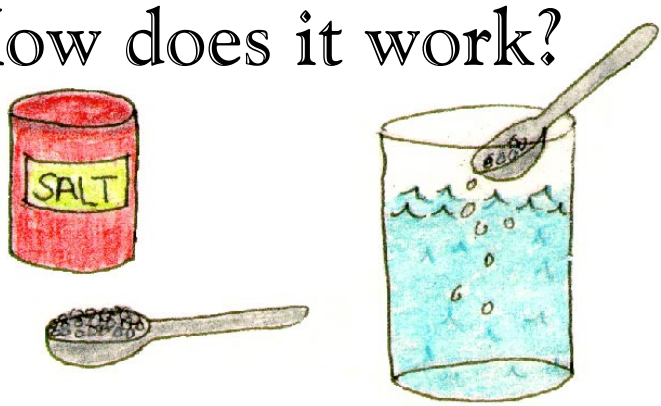
Micronutrients are usually supplied in chelates, which are special chemical forms readily available to plants. One commercial form of hydroponic micronutrients is Fertrilon Combi.



Plants need seven micronutrients in very small quantities. If any micronutrient is missing, the plant will suffer and produce less yield and poorer quality.

Note: Micronutrients may also be supplied with sulfate or chloride compounds of the necessary minerals such as zinc sulfate or zinc chloride. These may be less expensive than the chelates, and easier to obtain. However, the sulfates and chlorides may not be as easy for the plant to use, especially in pH changing conditions.

How does it work?



If you add a teaspoon of common table salt to a glass of water, it "dissolves" or disappears in the water. Although you can no longer see the salt, you can taste it in the water.

The salt has broken up into two parts, a sodium ion (Na^+) and a chloride ion (Cl^-). These two parts are now available to plants, if the plant needs them. A plant cannot use the dry salt in the teaspoon, it needs its food dissolved in water. In hydroponics, we use a few different salts like table salt to provide the plant with the nutrients it needs.

Calcium nitrate supplies one calcium and two nitrate for the plant.

Calcium nitrate provides both calcium and nitrate for the plant, two very important foods. A small amount of calcium nitrate dissolved in water supplies two necessary ingredients for plant growth.
All hydroponic nutrients must be soluble, or able to dissolve in water.

Making Hydroponic Water

International Institute Formula

This formula used in UN hydroponic projects is a two part liquid nutrient. The formula was adapted from one designed by Dr. Felipe Calderón.

GROW (A)

(grams per 10 liters)
Monoammonium phosphate (12-52-0) 340
Calcium nitrate 2080
Potassium nitrate 1100

MICRO (B)

(grams per 10 liters)
Magnesium sulfate 492
Boric acid 7.30
Copper sulfate 0.48
Manganese sulfate 2.00
Magnesium nitrate 414
Ammonic molybdate 0.02
Iron chelate 16.92
Zinc sulfate 1.2

Instructions

1) Obtain 4 liters (1 gallon) of clean water
2) Measure 2 teaspoons of GROW and add to the water.
3) Measure 2 teaspoons of MICRO and add to the water.

Young seedlings should receive reduced concentration or half normal solution. Mature plants on hot sunny days receive half concentration of nutrient. This is because the plants will transpire more water on hot days by using water to keep cool.

per liter	cc	ml	grams	teaspoon
Seedlings	2.5	2.5	2.5	1/2
Cool cloudy days	5	5	5	1
Arid hot days	2.5	2.5	2.5	1/2

Bradley Hydroponics

Bradley Hydroponics dry hydroponic nutrients supply separate formulas, based on the part of the plant that is desired. These include a Root, Grow and Bloom nutrient, Calcium nitrate and Magnesium sulfate.

Amounts of nutrients used per 1000 liters to make up Root, Grow and Bloom nutrients

Compound	Grow grams	Root grams	Bloom grams
Calcium nitrate	1062	1062	1062
Magnesium sulfate	492	492	492
Potassium sulfate	252	280	300
Potassium nitrate	293	200	200
Monopotassium phosphate	136	250	250
Iron Sulfate	17.75	17.75	17.75
Manganese sulfate	5	5	5
Copper sulfate	0.4	0.4	0.4
Zinc sulfate	0.4	0.4	0.4
Boric acid powder	10	10	10
Ammonium molybdate	0.03	0.03	0.03

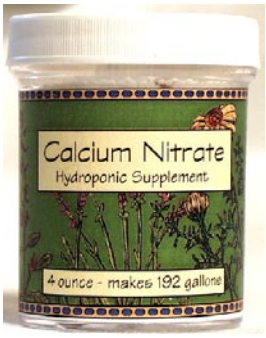
Grow nutrient is used to develop sufficient green growth until the plant is ready to bloom or mature roots. Grow nutrient can be used throughout the life of the plant, but root development is likely to be poor.

Root nutrient has extra phosphate to help build strong roots. The nitrogen is reduced to decrease green plant growth. Root nutrient is used for root crops once they have a full top growth.

Bloom nutrient has a reduced nitrogen level and increased potassium to encourage blooming.

Using Dry Nutrients

GROW
Part 1



Calcium Nitrate
Part 2

Magnesium Sulfate
Part 3

Use 3/8 teaspoon of GROW per 4 liters (1 gallon).

Use 3/8 teaspoon of Calcium Nitrate per 4 liters(1 gallon).

Use 3/16 teaspoon Magnesium Sulfate per 4 liters (1 gallon).

Container with 4 liters (one gallon) of clean water

Instructions

1) Obtain 4 liters (1 gallon) of clean water
2) Measure 3/8 teaspoon of GROW, add to water and stir.
3) Measure 3/8 teaspoon of Calcium Nitrate, add to water and stir.
4) Measure 3/16 teaspoon of Magnesium Sulfate, add to the water and stir.

pergallon	cc	ml	grams	teaspoon
Seedlings	2.5	2.5	2.5	1/2
Cool cloudy days	5	5	5	1
Arid hot days	2.5	2.5	2.5	1/2

La Molina Formula

The la Molina formula was designed by Alfredro Rodriguez of Peru. It has been used for many years in projects in Peru and well tested at the University.

Solution A

(grams per 10 liters)
Potassium nitrate 1100
Ammonium nitrate 700
Calcium super phosphate 360

Solution B

(grams per 4 liters)
Magnesium sulfate 440
Boric Acid 3
Fetrilon Combi* 30
* Fetrilon Combi is a chelated fertilizer made by BASF.
It has 9 % MgO, 3 % S, 4 % Fe, 4 % Mn, 1.5 % Cu, 1.5 % Zn, 0.5 % B and 0.1 % Mo.

La Molina liquid solutions are added to a liter of water as 5 ml of A and 2 ml of B. The 14 liters of solutions makes 2000 liters or 500 gallons of hydroponic nutrient, enough for 250 pounds of food.

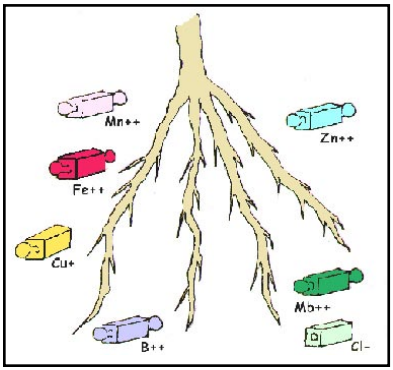
The amount of nutrient added to the water is varied according to the climate and the age of the plants. For seedlings, the nutrient strength is reduced by half. One cloudy days the nutrient is made full strength but if there is an arid climate or extra sunreduce the amount of nutrients by half.

per liter	cc	ml	grams	teaspoon
Seedlings	2.5	2.5	2.5	1/2
Cool cloudy days	5	5	5	1
Arid hot days	2.5	2.5	2.5	1/2

One liter

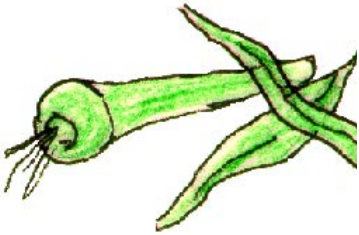
Adding Minerals for Human Health

Plants pick up other minerals in the soil. Studies show they can include over 60 additional elements in their tissues. While plants do not appear to need these elements , animals do. Of these minerals, about ten are important for human health.



For a hydroponic crop to be completely nutritious, minerals for human health should be added to the hydroponic nutrient. These minerals might be in the water anyway, but adding minerals ensures health.

Stones or pebbles can be added to the hydroponic water for some minerals.

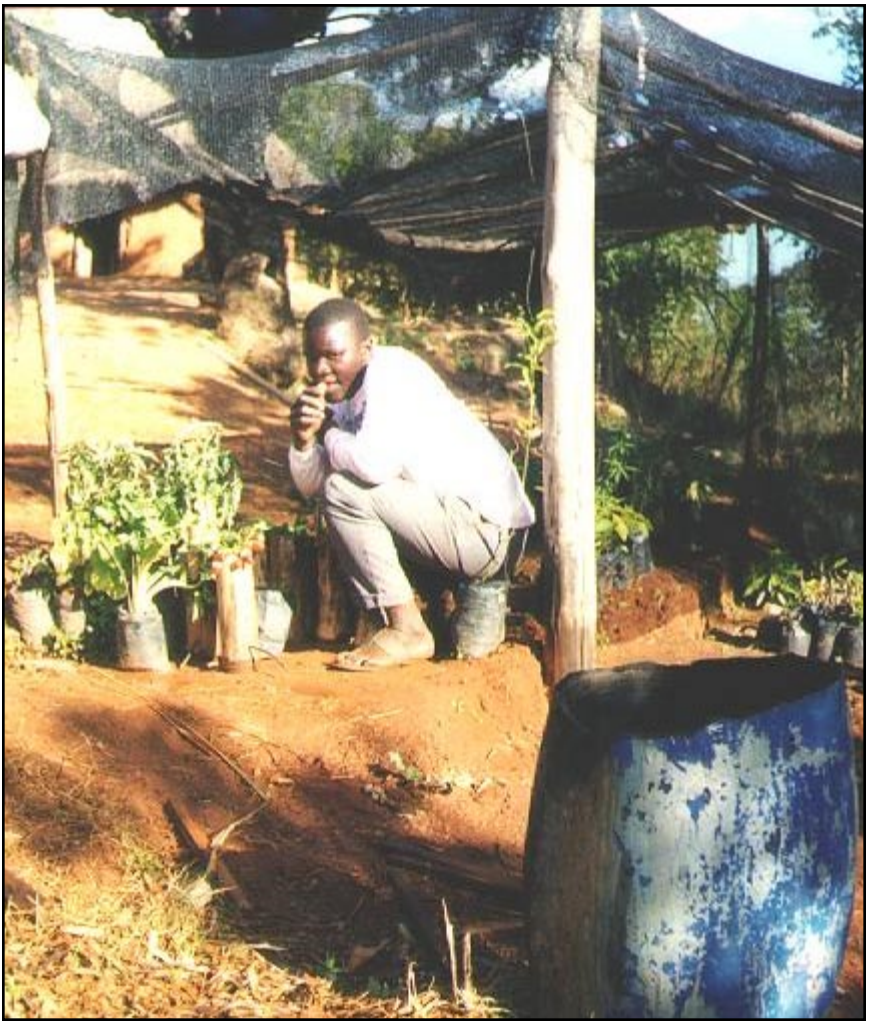


Seaweed or kelp has trace minerals. Try to ensure the seaweed is from unpolluted waters.

Liquid trace mineral supplement from drug store can be added to water.

A water soluble trace mineral supplement purchasedand added to hydroponic water.

Note: Adding a few rusty nails may ensure that iron is present. Seawater can be added as a supplement. If seawater is available, add one liter per 100 liters of nutrient solution.



The hydroponic greenhouse at an African village. The blue tank in the forground contains an organic hydroponic nutrient made of bat guano and worm castings.

7. Organic Nutrients

Even though commercial hydroponic nutrients are available, you may not be able to obtain them. It is possible to make hydroponic nutrients at home. Hydroponic plants can be grown with inorganic or organic nutrients, and organic nutrients can be made at home.

Inorganic - the chemicals are mined or formed by a chemical process and purchased from distributors. Each nutrient is in a form the plants can use.

Organic - the nutrient is made of animal or plant parts, including manures, urines, dead animal bodies and dead plants. The nutrients must be digested by bacteria before they are in a form the plants can use.

Organic Nutrients

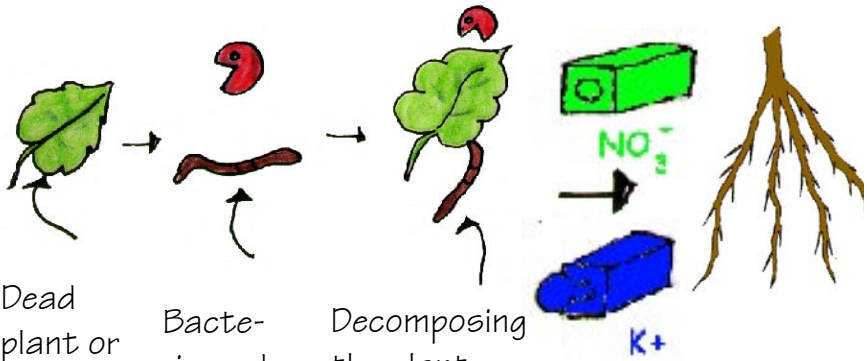
Organic nutrients can be made out of materials such as chicken manure, organic waste and straw. These nutrients usually will work in hydroponics, but experience is required to learn how to prepare an excellent nutrient.

Organic hydroponics can be more difficult than inorganic hydroponics. Many more things can go wrong. We recommend that home gardens are started with inorganic nutrients. Organic nutrient can be tested going slowly, step by step. Once experiments of organic nutrients are successful the garden can be converted from commercial nutrients

Cautions -Organic materials may be polluted. As an example, horse manure can be from horses that were dewormed. Bat guano or bat droppings are made of digested insects that may have been sprayed with insecticide. Cancer can be traced to contaminations such as these, so know the sources of your materials.

How does it work?

When animals or plants die, their bodies will be "removed" or broken down by decomposers. These decomposers include many things that eat dead material such as bacteria, and earthworms. As the bodies are removed, the organic elements used to make up their bodies are converted to an inorganic form like commercial hydroponic nutrients.



Dead plant or animal material

Bacteria and worms

Decomposing the plant

into inorganic nutrients roots can use

Organic hydroponics require that you also work to provide a home for bacteria or "decomposers" to convert these products into a usable hydroponic nutrient.

For the decomposers to work, they need a home that is comfortable for them to eat and grow. They will need the right amount of moisture, fresh air and comfortable temperature.

Two basic ways to make hydroponic nutrient are a composting bin and a worm farm. Each of these will help the organic materials break down into a usable hydroponic nutrient.

Making Compost Tea Hydroponic Nutrient

Compost - Compost means that dead plant and animal materials are mixed together and allowed to decay. Most composted material ranges from 1.5 to 3.0% nitrogen. Compost is a weak nutrient and it will take several cups to produce an effective nutrient. Compost will be richer if it is composted with enough oxygen and moisture to reduce nitrogen loss.

Dead plants

Animal manures

Layer manure and plant material

Mix often to give it air

Water often to keep it moist

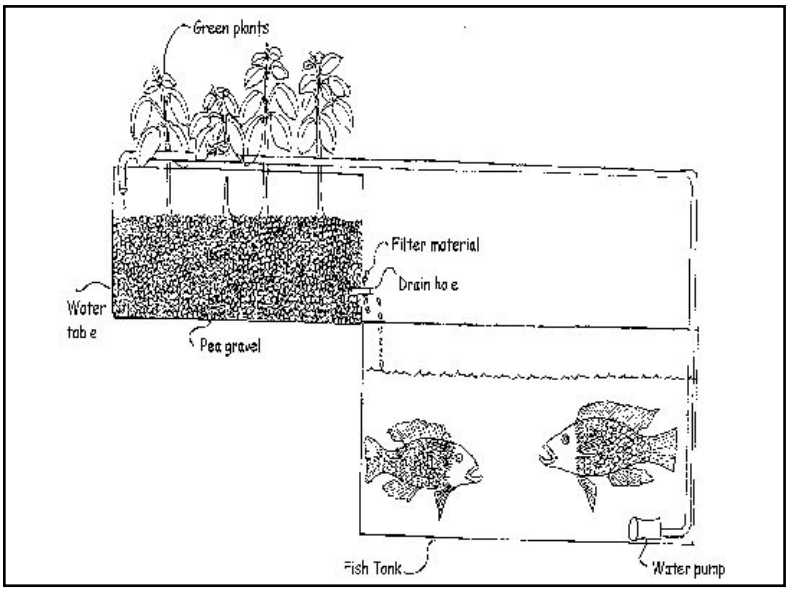
Finished compost looks like soil

Cup of compost

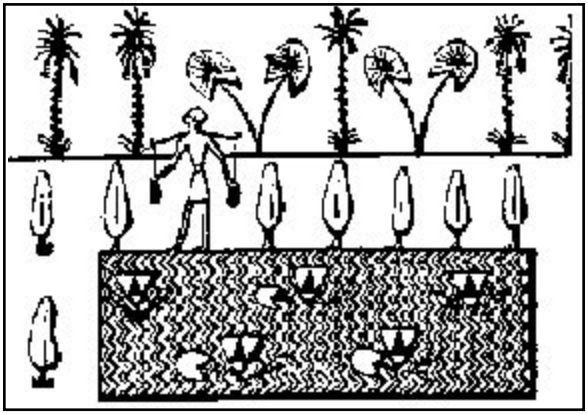
Cup of compost as hydroponic nutrient

Note: Compost may not have enough nitrogen to be an effective hydroponic nutrient.

Fish water as Hydroponic Water



Water from a fish tank or a fish pond makes an excellent hydroponic water. Fish waste usually includes ammonia, and plants with large amounts of green foliage, such as herbs, do well with fish wastewater. Changes in pH can make iron unavailable, so adding chelated iron can improve fish water



Ancient Egyptian gardens included ponds of tilapia fish. The fish water was removed in buckets and then used to water the containers of plants in the garden. This may be ancient organic hydroponics because plant nutrients are provided in the water.

Organic Hydroponic Nutrients

Worm castings - the very black soil left from worms is usually twice as rich as good compost. It often has 3% nitrogen so it can be used for most plants and is an excellent bloom nutrient.

Manure - manure or animal waste has nitrogen (2-5%), potassium (1-5%), phosphorus (1.5%) and sulfur (0.5%). If manure is not composted, it may damage roots and emit a strong odor. Manures may contain diseases so they must be handled with care. It is usually better to use composted manures.

Wood ashes - contain phosphorus (2-8%), potassium (5-14%) and calcium (33-45%). Ashes can be added to organic nutrient to correct nutrient deficiencies. Ashes can also be added to some growing media.

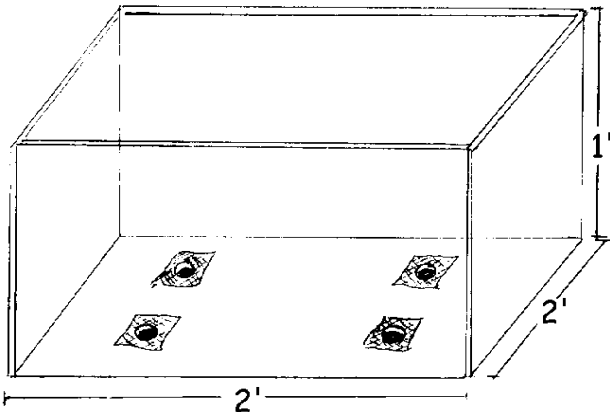
Bone ashes - source of nitrogen (2-4%) and phosphorus (4-7%) and calcium (33%). Bone ashes can be added to water or growing media.

Iron - scrapping from rusty iron can be added to nutrient solution or an iron nail can be placed in nutrient solution container.

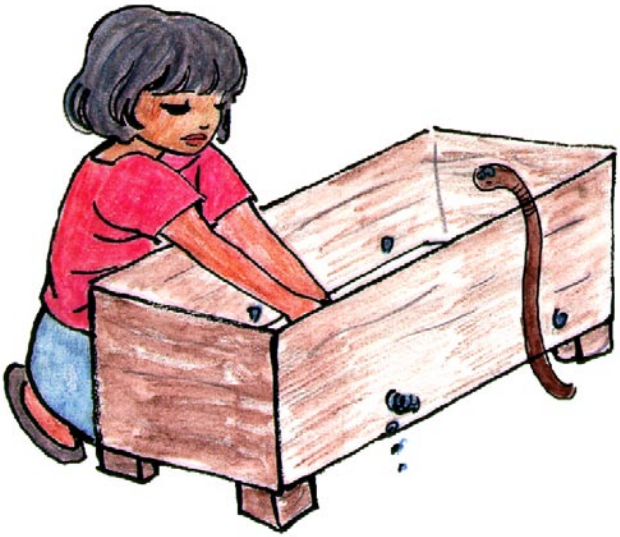
Bat guano - Bat guano is a good Grow hydroponic nutrient. It contains 8% nitrogen, 4% phosphorus and 2% potassium. It will make a better nutrient if mixed with ashes.

Seaweed - Seaweed will add important trace minerals to the organic hydroponic nutrient. This is important for human health.

Making a Worm Farm



A worm farm is made of wood or plastic. The box has vents with screens to allow water to drain.



The worm farm is built in a container at least .5 x .65 x .65 meters (1.5' x 2' x 2'). A cover is used the keep the area dark because worms do not like light. Four drain holes about 1.25 cm (1/2") diameter should be cut in the bottom of the tub. Nylon screen is placed over the holes, and secured so the worms do not leave.

The worms need a soft warm bed for their home. The worms will also use the bedding material for food.

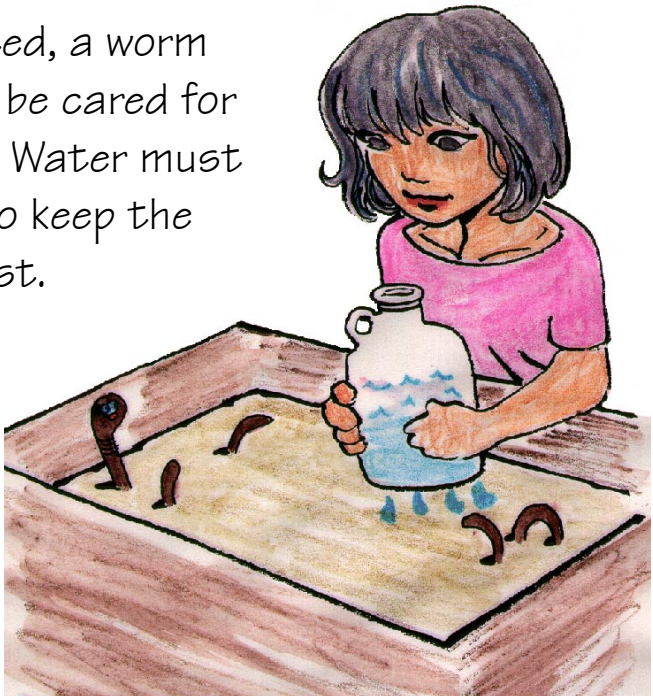
A good mixture for a worm farm bedding is:

1/3 top soil
1/3 decaying leaves
1/3 coffee grounds or cardboard

Worms can be found in rich soil, or perhaps purchased from a store. You will need about 1000 worms to start.

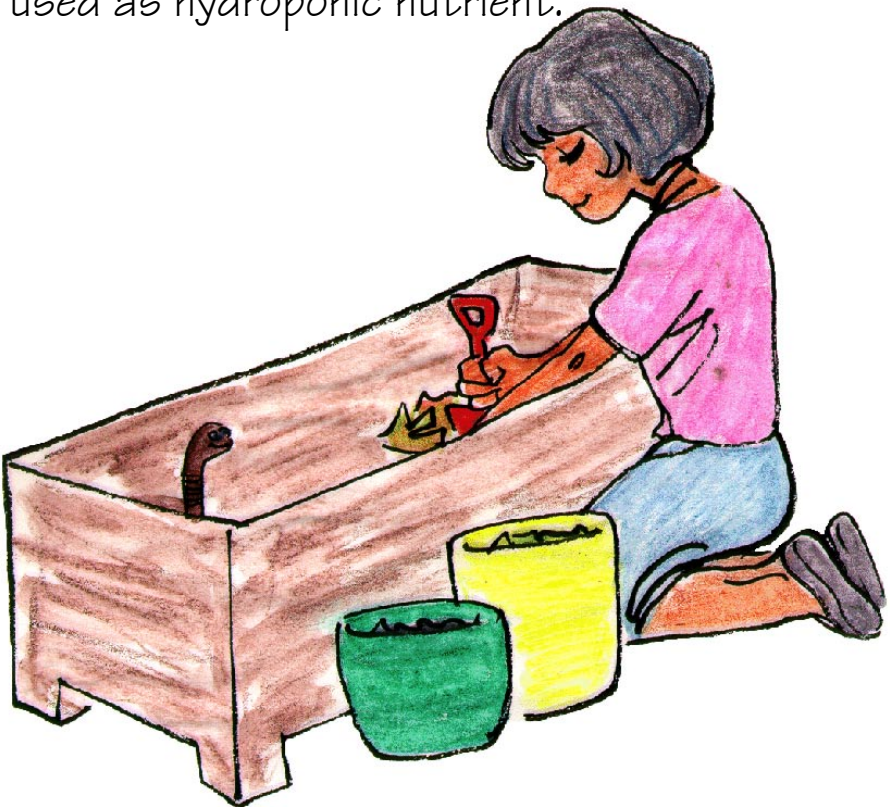
1000 worms should weigh about 400 grams (one pound) and should be enough to digest about 200 grams (1/2 pound) of plant material every day.

Once started, a worm farm must be cared for every day. Water must be added to keep the worms moist.



Each day the worms are fed any household garbage and left over plant material from the garden.

Worm castings are the darker crumbly material in the worm bed. This is material that has been digested by the worm, and can be used as hydroponic nutrient.



Once a month the worm farm can be harvested to obtain hydroponic nutrient and extra worms. Before harvesting sprinkle water on one side of the worm farm. In about three days, the other side will have dried, and all the worms will have moved to the wet side of the farm.

Remove the top organic material from the dry side until you find the black bottom material (worm castings), and remove for use for making hydroponic nutrient. Return the top organic material to the worm farm, add more topsoil, leaves or coffee grounds, and water the worm farm.

Making Worm Casting Nutrient Water

Worm castings are placed in a old sock or some cloth bag to keep large pieces out of the nutrient water.

A cup of worm castings in placed in the sock and the sock in hung in the water. The nutrient water should have a color similar to tea.

Worm farm nutrient is best for plants in bloom such as tomato and bell pepper. It is also good for watercress.

One bed grower supplies all seedlings for the entire 20 bed garden.

The floating bed grower is hand aerated twice a day to provide oxygen for the roots.

8. Day to Day

The home hydroponic garden should provide about nine pounds of food every day. It has to be properly managed to continue to produce food. This means that seeds have to be planted, seedlings transplanted into growers, and plants pruned and trimmed to ensure vegetable production.

As you harvest vegetables each day, new seeds should be planted to replenish the garden. There are basically three ways that vegetables are harvested.

Whole Harvest - the entire plant is harvested at once. This includes carrots, onions, turnips, and beets.

All plants completely harvested will require new seeds or seedlings to be put in their place as they are harvested. This keeps the garden fully stocked with plants when you need them.

Fruit Harvest - only the fruit is harvested and the plant is allowed to continue to grow. New blossoms form and new fruits are harvested. This includes bell pepper, tomato, eggplant, potato, and sweet potato.

Plants with fruit harvest only occasionally have to be replaced, so just a few of these plants being grown as spare seedlings should be sufficient to keep the garden growing.

Partial Harvest - only a part of the plant is harvested and then rest is allowed to grow back. This includes most herbs, ginger, some lettuce, basil and mustard and chard. For example, a lettuce plant harvested from outside leaves can produce eight times the leaves as a plant pulled for a single harvest.

Partial harvest plants may have to be replaced every month, so a steady supply of these plants should be started in the seedling growers.

Seedling Growers

Two tub growers in your garden should be reserved for starting seedling plants for the 18 bed garden. For the garden designed in chapter two, the following seeds should be growing in the seedling grower at all times.

Lettuce - at least four per day
Leeks - 4 per day
Onions -2 per day
Turnip - 2 per day
Spinach - 1 per day
Green onions - 20 per day

Other plants that should be growing in the seedling grower for emergency replacement are

Bell Pepper - 10 seeds
Tomato - 20 seeds
Eggplant - 10 seeds

Grow Out Beds

All other growers in the garden are for transplanted seedlings, or are used for starting seeds that cannot be transplanted. In the garden, bed plants grown from seed include watercress, carrots, potatoes, radish, sweet potatoes, green beans, peapods, squash and zucchini.

Transplanting

Seedlings are grown in a seedling bed and then transplanted into a larger grower. Some seedlings will take longer to grow than others. For example, lettuce grown in a seedling grower is ready for transplanting in about 23 days after seeding and bell pepper in 52 days.

Transplanting must be done carefully not to damage the small seedlings.

Starting plants from seeds

Many vegetables begin as seeds. Most seeds are designed not to start to germinate until the environment is "just right". This means that most seeds need a good temperature and good moisture conditions before they will germinate. Some plants can take root whenever a branch or stem reaches the ground. Others, like basil, can take root from a stem placed in the media.

Most vegetables used in hydroponics are germinated from seeds. A seed contains all that is needed to start a new plant. Most seeds contain enough food for the plant to survive the first few days of life.

Many seeds have a structure that will allow them to survive dormancy. This allows the seed not to begin life at a difficult time, such as the start of winter. Most seeds have a coating or shell that requires certain conditions (such as being soaked in water at a certain temperature) before it will germinate. Starting seeds in hydroponics is easy if the seeds desirable conditions are met.

A sunflower seed germinating. Roots and leaves appear from the parts of the seed, with roots seeking dark and water and leaves seeking light and air.

Most seeds contain enough food to grow for a few days, but then they will need to get their nutrients from the outside environment. In hydroponics, nutrients are supplied in the water. Seedlings should also be kept moist, but not drowned in water. When the roots are kept warm 22°C (72°F) seedlings can take up more nutrients from the water.

Transplanting

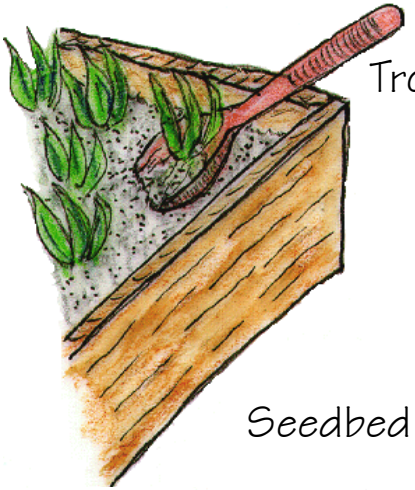
When a seedling is two to three inches tall, it is ready for transplanting into a larger container. After transplanting the seedling should have root and top room to grow into a mature plant. Specific information on space is given in the Chapters 10-14 on plants.

Transplanting a seedling can be stressful on the plant. Take care in moving the plant by carefully lifting the roots from the growing media.

Some plants such as corn, snow peas and carrots do not transplant well, and are started in containers they will have until they mature.

A seedling, when transplanted into a bigger growing container, is stressed at first. In most cases, it will help the plant survive if you spray it with nutrient solution. The plant absorbs nutrients through its leaves as well as its roots and keeps the plant nourished until the roots get reestablished in the new growing container.

Transplanting seedlings



Seedlings are germinated and grown in a seedling grower.

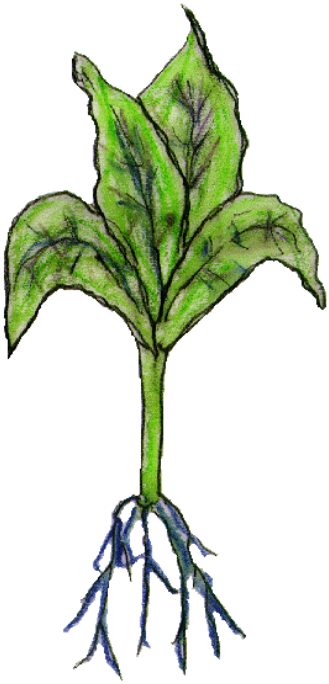
A seedling is supported at the stem.

Use a trowel straight down to get all roots.

Try to catch as much root as possible.

Let extra media fall back to grower.

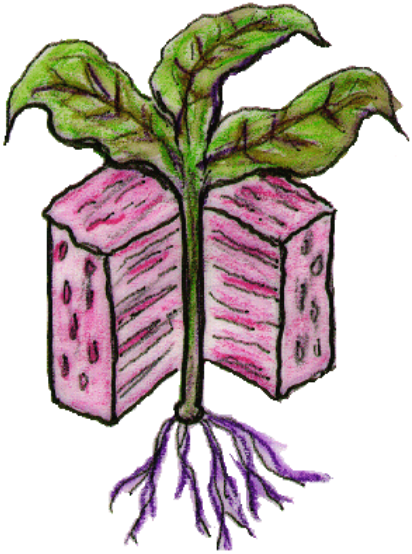
Wash the growing media from the roots without touching or harming them.



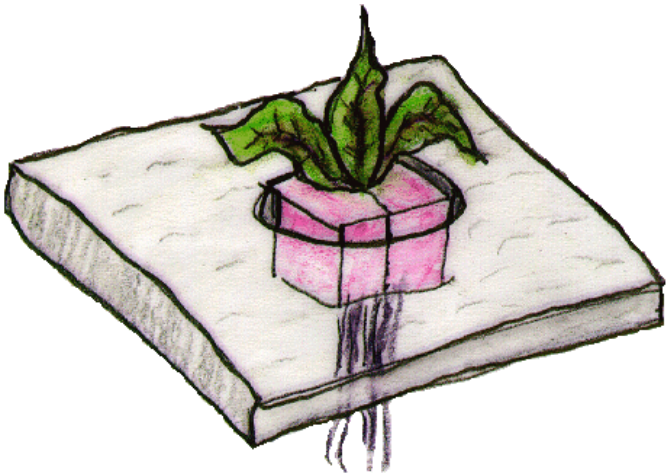
Select and plant only the best seedlings. Reject seedlings with poor root, stem or leaf growth.

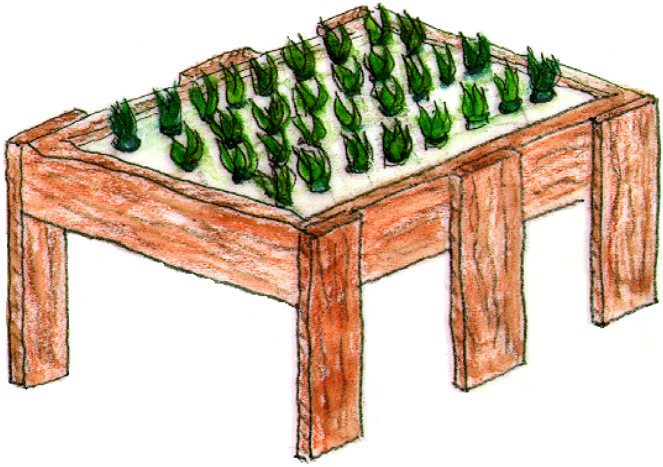
To use in Floating Bed Growers

Dampen sponge cube in nutrient solution.

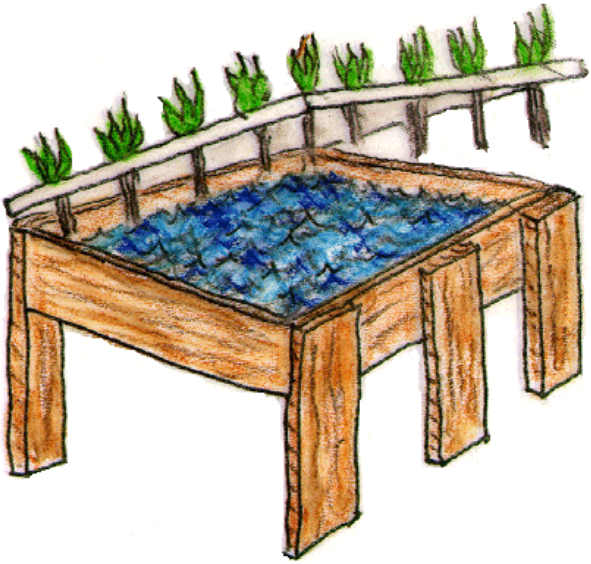


Leave plant stem 1 cm (2/5") below the surface of the cube.





Fill all holes in the sytrofoam sheet with the best seedlings.



Lift the styrofoam sheet to make sure no roots are caught between sheet and sponge. All roots should hang down straight.

Pollination

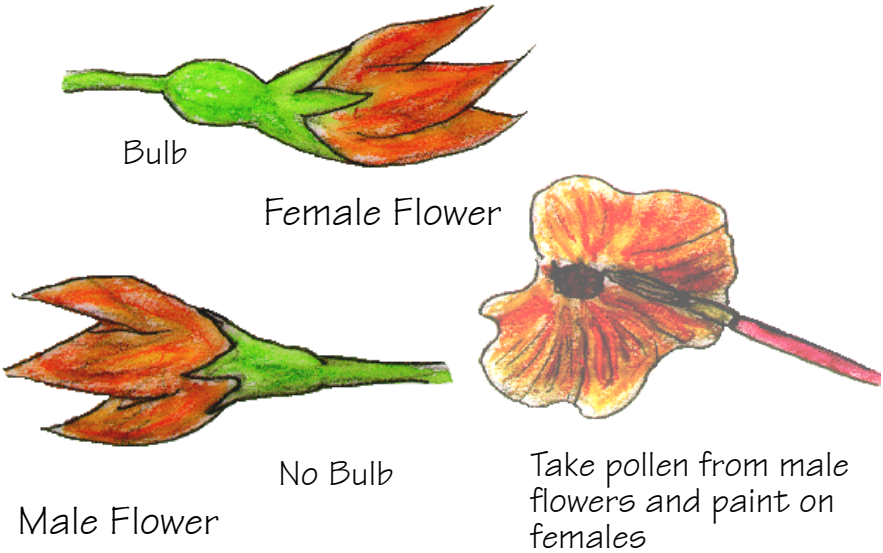
Some plants have to be pollinated or fertilized to produce fruit. Many vegetables that come from flowers (such as squash, tomato, and cucumber) require pollination. This means that the pollen of one plant is used to fertilize the flowers of the other. The pollinated flowers then dry off and grow on to become fruits and vegetables.

When plants are grown outside, most flowers are pollinated by the wind, or by insects. When hydroponic plants are grown indoors or in protected areas, the normal pollinators may not be there and the fruit will not form.

The solution is to pollinate the plants yourself, to ensure fruit production.

Squash Blossom - Squash, cucumber, melon and zucchini blossoms all must be pollinated to ensure fruit forms. This required taking pollen from the male flowers and placing it on the female flowers.

Pollinating squash blossoms



Pollinating Tomatoes

The small yellow flowers become tomatoes if the flowers are pollinated. A tomato plant is self-pollinating which means that the pollen from a plant can be used to pollinate its own flowers.

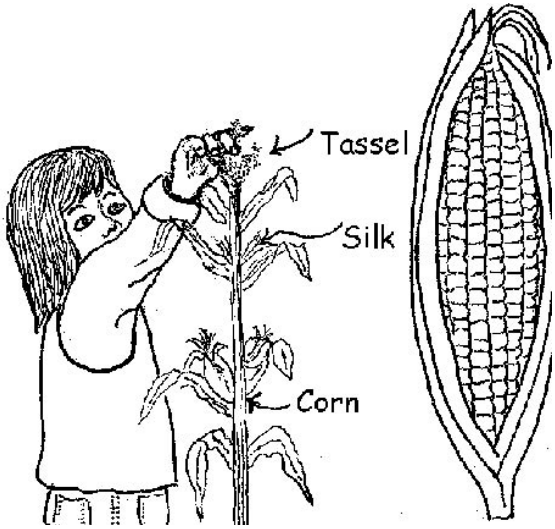
In the outdoors, a tomato plant is usually pollinated by the wind. In large commercial hydroponic operations, each tomato plant is pollinated with a vibrator every day. The wand type vibrator is placed against each plant and it is vibrated to shake the pollen onto newly formed flower.

A tomato plant can also be pollinated by tapping it a few times to shake pollen onto flowers. You will know if it is successful because each flower will form a small green tomato after pollination. If the flowers wither without producing any fruit, it is probably a lack of pollination. It pays to tap each tomato plant once a day to pollinate new flowers.

Pollinating Corn

When an ear of corn first forms, there is silk tassel protruding from the corn ear area. This silk must be pollinated from the tassel above, or the corn will not form. Each piece of silk must be pollinated to form a single kernel of corn.

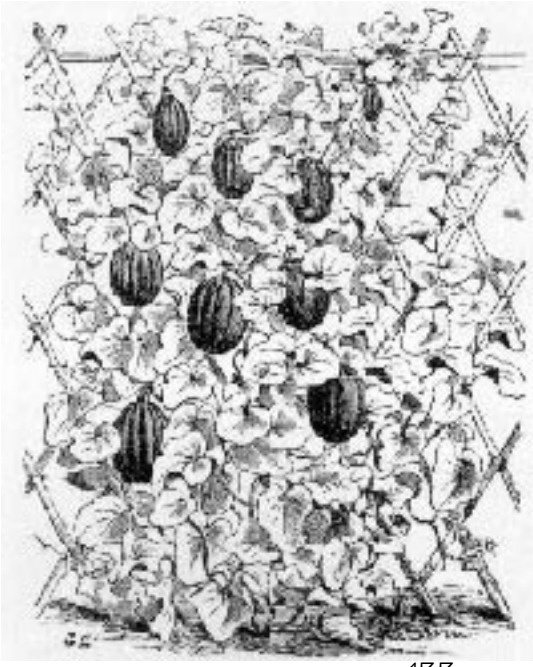
A tassel can be shacken each day to pollinate the silk, but it is more effective to place a tassel in a paper bag and use it to cover each silk and ensure all silk is pollinated. You will know it has been pollinated because the silk will turn brown and dry.



Pruning and Trimming Plants

Pinch off end of growing side shoots.

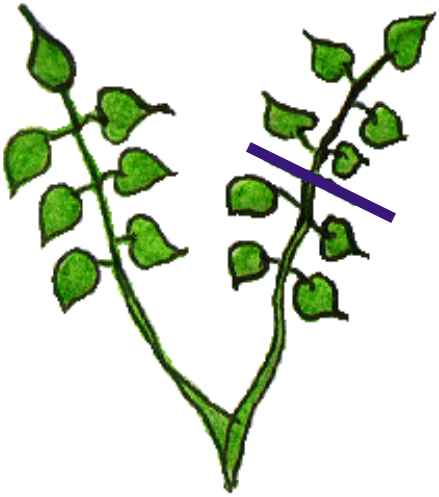
Pinch off stem two leaves beyond where fruit has formed.



Almost all vine crops grown in hydroponics will have to be supported with trellis or stakes, and they will have to be pruned to be controlled.

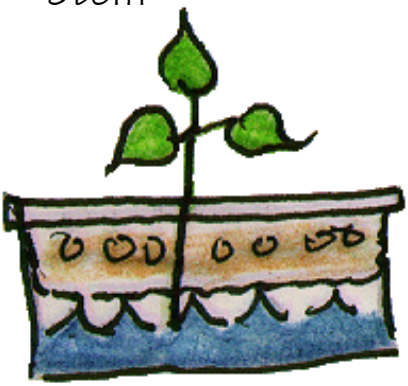
A trellis can also help support the fruit as it ripens.

New plants from Cuttings

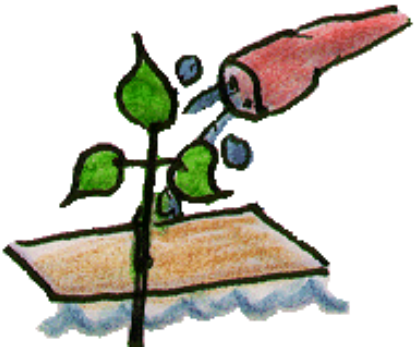


Take cutting with about 10 cm (4”) of stem

Take off lower leaves.



Place cutting in media. End should be in water.



Water with nutrient water.

Hand Watering Media Growers

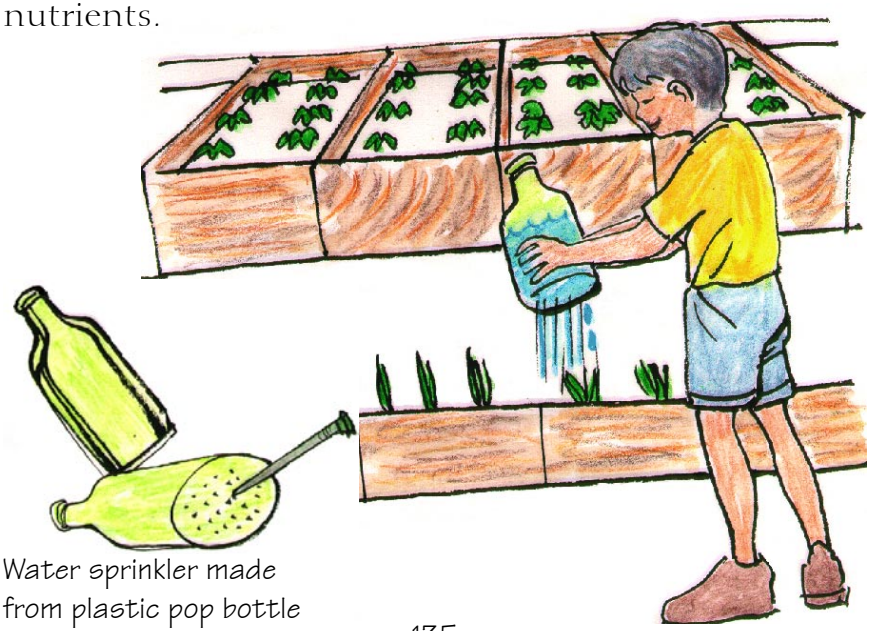
Every day tub and media bed growers should be hand watered with nutrient water.

A hand sprinkler can be made of a plastic pop bottle with holes cut in the bottom with a nail. Or a watering can be used. It is important to sprinkle the water all over the grower bed.

Water can be sprinkled over the stems and leaves of young plants and transplants. Youngest seedlings are watered carefully so as not to break the fragile stems and leaves or dislodge the young roots from the media.

Growers are watered until extra nutrient water comes out of the drain hole near the bottom of the grower. Be sure to have a container placed beneath the grower to catch the extra nutrient water. Excess water is poured on the grower the next day.

Each bed grower should require 4 to 8 liters (1 to 1 gallons) of water every day. On hot sunny days, more water may be required and a second watering can be done in the early afternoon. This hot day second watering should be with pure water without nutrients.



Water sprinkler made from plastic pop bottle

Hand Aerating Floating Beds

All plant roots need air, even those in floating beds. To keep growth of lettuce lush and full, it is necessary to hand aerate the nutrient water in the floating beds about twice a day.

This is done by lifting the floating bed out of the water with one hand and then hand stirring the water with the other. Stir the water for about 15 seconds.

Then carefully replace the floating bed of lettuce, making sure not to pinch any of roots on the edges.

Mixing Nutrient Water

Nutrients should be mixed in a container that does not let light through, and should be covered so light does not show through from the top. If light gets in, algae will probably start growing in the nutrient water.

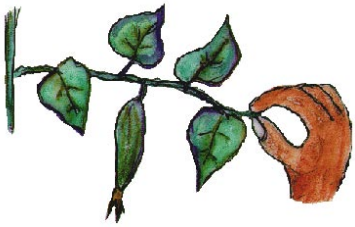
If algae does grow, it does not hurt the nutrient water, but it takes away some of the minerals that could have been used by the plants. So nutrient water should be kept in the dark, or mixed fresh every day to reduce algae growth.

Each nutrient should be mixed according to instructions on the labels. For example, La Molina formula is mixed one teaspoon per 4 liters (1 gallon) of fresh water. Worm nutrient is 1/2 cup per gallon.

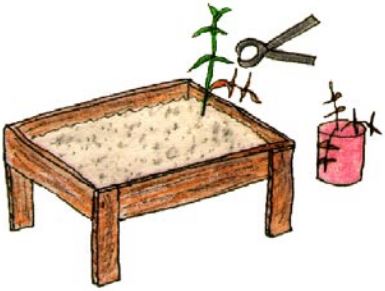
Inorganic Nutrients Organic worm soil nutrients

Daily chores for Home Garden

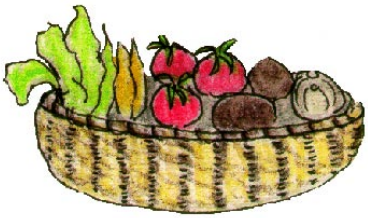
1) Morning and evening inspection for insects or eggs.



2) Prune back extra growth such as suckers on tomatoes and extra vine on cucumber.



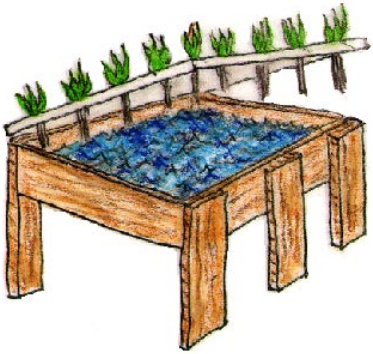
3) Trim away any dead materials



4) Harvest vegetables for the day

5) Transplant any plants to harvested areas, plant cuttings or seeds

6) Replace any transplanted seedlings with seeds



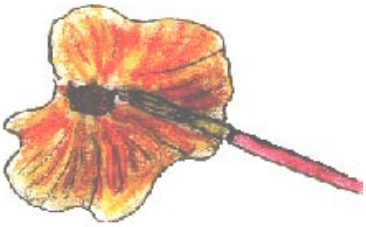
7) Hand aerate any floating beds twice a day

8) Water all meda bed growers. Pour water over any transplants or young seedlings

9) Gather cut off plant material, cut into small pieces and add to worm bed.

10) Sprinkle water over the worm bed

11) Mix nutrient water if needed



12) Hand pollinate all new blossoms.

The scarlet macaw windsock is used scare birds from the garden. A bright colored fluttering object may help keep birds away.

Use no Pesticides

In hydroponics, insect control is a problem and it is important ***never to use any chemical pest controls***. These poisons can be harmful to workers who apply them and to people who eat the food. In hydroponics, there is no soil to break down some poisons and so the poisons can accumulate in the food. **Never** use any pesticide or herbicide of chemical origin in the production of your home garden vegetables.

9. Pest Control

Insects

One of the biggest potential problems in a home garden is controlling insects that invade and start eating the plants. It is important to control insects to have a productive garden.

Prevention

Insects want to make their homes and lay their eggs where they will be left undisturbed. So part of insect management is to have a lot of activity, or interruptions of some kind. This includes hand watering the entire grower surface, visually inspecting the plants each day and watching for adult insects and eggs or larvae.

Most insect eggs require from four to six days to hatch, so there is time to discover and destroy any eggs or larvae. Pay attention to surface areas of growers, especially the edges when insects might try to lay their eggs.

Once the adult insect or larvae are recognized and then removed, the insect problem in hydroponics is reduced. Insect hunting should be done in the early hours of the morning or in the evening. After the sun has risen the temperature rises and insects hide to protect themselves. This makes them harder to locate during the day.

Disease

A disease can be caused by bacteria, fungus or virus. Plant diseases are rare in hydroponic culture. Most of the soil born diseases can be eliminated just by keeping soil out of the garden. However, some disease can be carried by insects, animals or people.

Environment

Air movement is important to plants. Plants confined in spaces with little airflow will be starved for CO_2 and can raise the amount of moisture in the air (humidity). This stale air problem can also encourage the growth of powdery mildew. Humidity should remain at about 65% or less for optimum plant growth. Temperature is also very important. Freezing temperatures will kill plants, and very hot, very dry conditions will cause stress. Try to create a garden where you can control temperature extremes.

Daily Patrols

If there is a lot of activity in the garden, a lot of daily patroling, insects may avoid the garden altogether. Insects perfer to lay their eggs in areas free from disturbances and activity.

Repealing plants

Some plants can repeal insects. These plants can be planted in an area surrounding the garden, or some can be planted in the growers to help keep insects away.

Some plants such as peppermint, chrysanthemum, feverfew, chives and garlic naturally repel insects. If these plants are included in the garden, it will help to control insect attack.

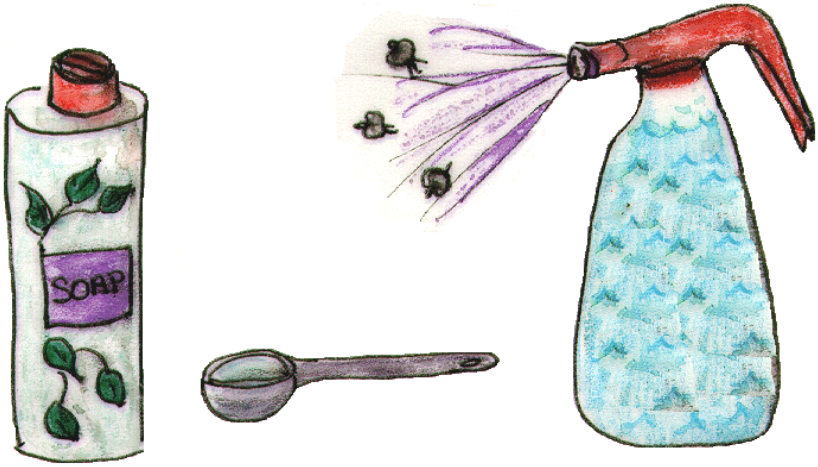
Garlic, chives, leeks and onion will help to keep aphids away. These plants can be placed in the corners of beds of more susceptible plants, such as tomato, to reduce the chances of insect attack.

Medicinal plants and culinary herbs known to repel aphids include yarrow, fennel, mint, cilantro, and caraway. Any of these can be planted in the corners of hydroponic growers to reduce insects.

Making Insect Control Sprays

Sprays can be made of soap and/or extracts of garlic, hot peppers, eucalyptus leaves, oregano, nettles, wormseed, rue, and tobacco. These sprays are used on the crop to control insects by being an irritant to existing insects and as a deterrent to others.

Soap Spray



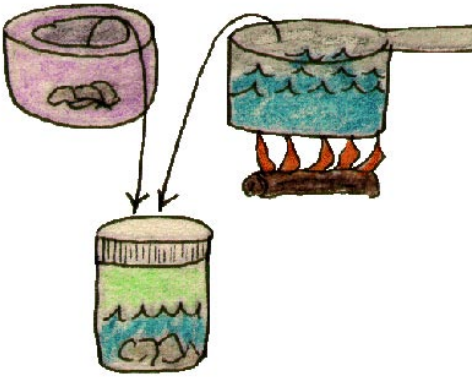
A soap spray is made of a household dishwashing detergent (such as a peppermint soap). Mix one tablespoon of soap with a liter (quart) of water. This spray can be used on plants to control aphids and small nude larvae.

Nutrient Water Spray

Nutrient water can be used as an insect control. It may not be as effective as the sprays such as garlic, but it can be used especially in the early stages to control insects. It has an added benefit as a source of nutrients for the younger leaves and tissues, and should increase plant growth in the garden.

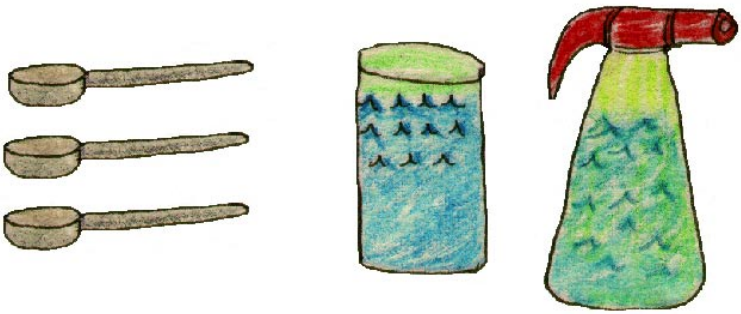
Making Garlic Spray

Grind or mash about 30 cloves of garlic.



Place garlic in a glass or plastic container and cover with boiling water.

Keep the container covered. It is best if used within 24 hours of preparation.



A spray is made by adding three tablespoons of garlic mix per half liter (pint) of water. It is then sprayed on garden plants.

Other sprays

Almost all sprays used to repeal insects are make in a manner similar to garlic spray. A strong tea is made from the substance and then used as a spray in the garden. Extra tea is kept in clearly marked bottles.

Hot Pepper Spray

The peppers are mashed and placed in a container of hot water for five days. The spray is made from three tablespoons of hot pepper mash per half liter of water.

Worm Castings Tea

The worm castings used from the worm farm for a hydroponic nutrient can be used as an insect spray when sprayed onto plants. The tea is made with worm castings soaked in water. The tea is strained through cheesecloth to remove particles that can clog your sprayer.

Oil spray

An oil spray will kill young larvae and eggs, but it must be sprayed directly on them. It can be made of any vegetable oil and water.

Caution: Many of the insect sprays are also poisonous to humans. Of all the sprays, garlic will probably be the safest but treat all as poisons and keep out of the reach of children.

Barriers and Traps

Night Insects

A light trap is created with a light over water to attack and kill night flying insects. If the family doesn´t have electrical source, they can use one candle in the middle of one half tire plenty of water with a small quantity of used motor oil and to put it when the sun light is gone. The additional quantity of motor oil improve the efficiency of the trap because it increase the brightness.

If the insect gets out of the liquid it will die the next day when the sun appears.
This trap it is very efficient for controlling brown or dark butterfly whose larvae damage leaves, roots branches and fruits. Since each female butterfly can lay 400 eggs, it is better to catch it quickly.

Slugs

A slug trap can be made by impregnating wet sacks with beer or yeast extracts. The slugs are attracted at night and can be gathered in the early morning. A quart jar half full of beer can be placed in the garden, attracting the slugs during the night. The slugs crawl into the jar and then drown.

Natural Predators

Many insects and animals eat insects, and some can be encouraged to make their homes in or near your garden. If you can obtain a balance, they will be able to keep the insects in control

Ladybugs - lady bugs feed on aphids and will patrol the garden to find them. Lady bugs make their homes in older rotting wood logs. If a lady bug home can be provided in the garden, it will help keep aphids down.

Predator wasps - Encarsia formosa is a wasp in the US and Canada that is a natural predator of white fly. The larvae can be purchased and then released into your hydroponic garden.

The wasp controls the white fly by laying its eggs in the white fly larvae. This keeps the white fly population in check, and the fly and wasp should remain in balance, if both are in the garden.

Bats - bats eat at night, and they will eat several thousand insects. They are especially effective in keeping moths out of the garden. A bat house can be built and placed near the garden. Bat guano is also an organic hydroponic nutrient.

Lizards - there are lizards that feed on insects. They can be encouraged to make a home in the garden and will patrol the beds for insects.

Spiders- The common house spider eats flying insects and will be especially effective against house flies. They should be allowed to make their homes among the garden growers.

White Fly
(Trialeurodes vaporariorum)

White fly is a very small powdery white fly that scatters in the air when you shake the plant. They damage the plants by piercing leaves and sucking the sap. Effected leaves will look speckled yellow or silvery.

The white fly lay their eggs on the undersides of leaves, and these eggs turn into larvae that then feed on the plant.

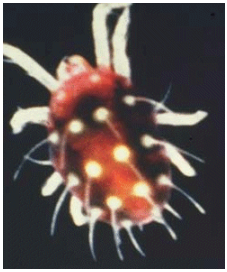
When white flies invade, they can be fought with predator insects like wasps such as Encarsia formosa or praying mantis. Plants can also be sprayed with a soap spray.

Yellow sticky cards - These cards covered in motor oil are placed throughout the garden. White flies are attracted to yellow blossoms are to yellow cards. When they land against the cards they stick to the motor oil and are killed.

Bright yellow cards or flags smeared with transmission or motor oil can be hung throughout the garden to catch white fly. The white fly is attracted to yellow and will stick to the card.

Spider Mites

(Tetranychidae acari)



Spider mites are small red spiders that appear as tiny red dots on the undersides of leaves. Unlike insects which have six legs and three body parts, spider mites have eight legs and a one-piece body.

These small spiders pierce the leaves with their mouthparts and drain the cell contents. Affected leaves have pale-yellow or reddish-brown spots. The undersides of leaves are coated with fine silk webs containing mite eggs. The first sign of spider mites is usually their fine webs, spun between buds to the tops of plants.

Spider mites are usually a sign of dry hot conditions and can often be controlled by keeping the plant and media area moist and at least 50% humidity. Spray with water and keep areas moist.

Spider mites are usually a problem during hot dry weather. They can sometimes be controlled by building a shelter around a grower to keep moisture in around the plants.

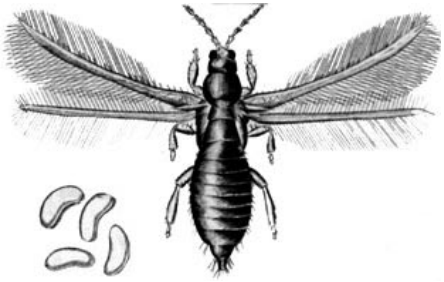
Control

One control method is to simply hose the webs off the infected leaves or spray the leaves with a mixture of flour and buttermilk.

Prevention

Spider mites can also be prevented by routine sprays of garlic, pepper and tobacco sprays. They can be controlled by removing affected plants.

Thrips
(Thysanoptera)



Thrips are black brown or red insects with two pairs of hairy fringed wings. They are small and hard to see. To determine if you have these tiny insects, place a white piece of material under the suspected plant and tap the foliage. The thrips will appear as black spots on the white background.

Thrips cause damage by rasping away at plant leaves, fruit, or flowers and sucking the sap. The curled leaves take on a silvery appearance. Thrips also transmit virus including spotted wilt on tomatoes.

Thrips are attracted to white blossoms and to yellow sticky cards. If aluminum foil is placed on the sideboards of the grower, or on the surface of the media under the plant, the thrips will become confused and not land on the plants.

Any time thrips are found, infected parts of plants or whole plants should be removed from the garden and placed in a covered container with water. This will kill the remaining insects so they cannot return to the garden.

Water stress encourages thrips so be very careful during hot sunny weather to make sure your garden plants have plenty of water.

Thrips can be killed with a soap spray, tobacco tea, oil and water or field lark spur. Sulfur dust can also be used. Garlic tea spray makes a good preventative.

Aphids

Myzus persicae

Aphids are soft bodied crawling insects about 0.5 cm (0.20") long. Some aphids can fly and will land on plants. Others crawl onto plants or are brought to your garden by ants.

Of all the insects that can attack your hydroponic garden, aphids are among the worst. A single female aphid can reproduce asexually, and produces female offspring, so a garden can be filled with aphids in a hurry. Aphids prefer nitrogen rich plants, and they will prefer your nitrogen rich hydroponic plants.

Aphids are eaten by ladybugs, lacewings and wasp parasites. All of these can be encouraged to live in your garden. Homes can be built for all three types of insects.

A spray of peppermint soap can kill aphids. It will only be effective until it dries so be sure to spray the soap directly on them, or it will be ineffective. Be sure to spray on the undersides of leaves, where the young are being raised.

Ants

Ants use aphids like a domesticated cow, actually moving them onto new plants and then milking them for the honeydew the aphids excrete. For this reason ants must be controlled in your garden. If you have bed growers this can be accomplished by wrapping 10 cm (4") section of leg with sticky rags.

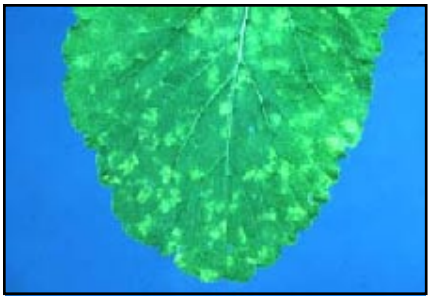
Fungus

Hydroponic gardens can be infected by some of the molds and mildews. Two that are quite common are powdery mildew and downy mildew. Both of these are carried in the air and can infect your garden.

Powdery mildew

This starts as a very small white round spot of the upper side of leaves. It is often seen on squash or cucumber leaves. The spot will start to grow bigger and then more spots will appear, unfortunately spreading to new plants and more growers.

Powdery mildew should be handled the moment it is found. Any affected leaves should be carefully removed, placed in a plastic bag and removed from the garden area. Your hands should be washed after picking the leaves. Also, the humidity in the garden should be lowered if possible, and the air flow should be increased. Or spray with milk.

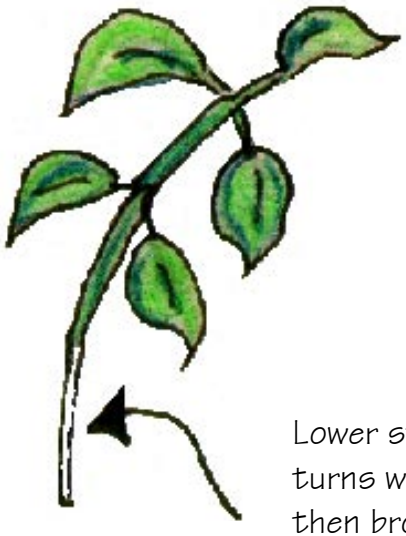


Downy mildew

This occurs on the undersides of leaves during cool damp conditions. It is spread by water and air and usually spread from decaying plant material.

Seedlings

If you discover that the seeds are rotting instead of germinating, it is possible that the environment surrounding the seedling is too wet. The moisture for proper seed germination is about 65% moisture. There must be some air for the seed to breathe.



Lower stem turns white, then brown

Damping off -

As seedlings first begin to grow, you may notice a whitening of the lower stem that then dries out and shrivels to brown. This is called damping off, and it is caused by a soil born fungus.

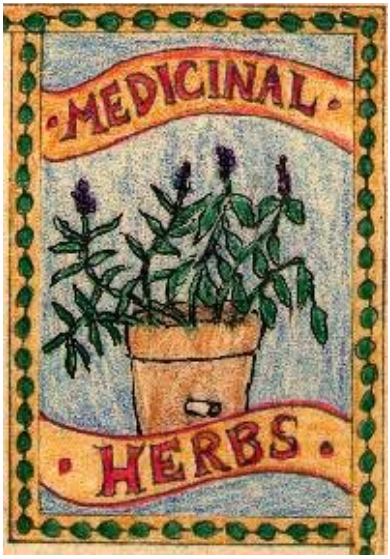
If you start your seeds in new clean hydroponic media, damping off should not be a problem, but if you are using soil to start seedlings, or using recycled media, damping off can be a problem.

When a seedling has damping off it must be discarded. The media or soil being used to raise that group of seedlings should also be discarded.

Occasionally the stems of seedlings will become a white color because the seedling is reaching for the light. If you see seedlings that are leaning towards the light and bending at the stem, this is due to low light conditions. The seedlings need more sunlight and sunlight on all sides.

St. John's Wort

10. Medicinal Herbs



Some herbs are used to heal and not necessarily used for food. Different cultures have discovered and used a variety of plants and plant biproducts as medical remedies. Today, in modern western medicine, 50% of all prescription remedies are derived from plants.

Some medicinal herbs are also used with religion, with rite and ceremony and the only intention here is to describe how to grow hydroponically and mention some known uses.

The medicinal herbs presented here are a few of the common varieties used in some cultures. In areas where a plant is described (such as echinecea, grown primarily for its root) the methods of hydroponic culture will probably be similar for simlar types of plants more commonly used in other cultures.

The intended uses of the medicinal plants are derived from both folklore and scientific evidence, and no recommendation of any herbal remedy is given.

Medicinal herbs can be grown hydroponically and the possibilities are that hydroponics and selective nutrients offer a method to enhance or change medicinal properties.

Further Info: Chevallier, Andrew, 1996. The Encyclopedia of Medicinal Plants, DK Publishing, New York.

Calendula

(Calendula officinalis)

Also called pot marigold. The flowers are used as a medicinal herb to reduce inflammation and treat chronic infections.

Planting Info:
Propagated by seed.
Space between rows: 20 cm (8")
Space between seeds: 20cm (8")
Depth: 1 cm (1/3")
Germination: 14 days
Harvest: 60 days

Medicinal uses:
Antiseptic and effective against fungus, bacteria and virus.
Used on open wounds to prevent infection.
Used on skin disorders such as athlete's foot, diaper rash, ringworm and yeast infections.

Calendula flowers are edible and can be mixed into salads or stews. They can also be added to a sauce for an interesting flavor and texture. The orange color looks very good in frostings and curries.

Calendula Tea: Use about one flower steeped in hot water for five minutes. Used against suspected infection.

Calendula Poultice: Pour 1/2 cup of water over 1 cup of Calendula flowers. Place cloth filled with wet leaves over injured area. Replace as desired. Use for wounds and skin disorders.

Chamomile
(Anthriscus cerefolium)

Chamomile flowers and leaves are mostly used for teas and medicinal tonics, but they are also used to add texture and bind foods such as meatloaf or dressing.

Planting Info:
Propagated by seed and by root division.
Space between rows: Broadcast
Space between seeds: Broadcast
Depth: Surface
Germination: 20-25 days
Harvest: 90 days

Medicinal uses:
Provides manganese which can be helpful for seizure disorders.
Added to diet for stress or sleep disorders.
Used for ulcers and wounds.
A chamomile tea is used for a restful sleep, reducing stress and nervousness.
Helps digest food and increases appetite.
Apply for dry skin disorders, including scalp.

Chamomile Tea: Two teaspoons or more of flowers steeped in hot water for five minutes. Can be used with peppermint for sleep.

Herbal Pillow: Chamomile flowers can be dried and stuffed into a pillow for sleep. Should be replaced each month.

Live plants can be placed near sleeper in bedroom.

Caution: Handling live plant can cause dermatitis.

Chives

(Allium schoenoprasum)

Chives is a culinary and medicinal herb that has a delicate onion like flavor.

Planting Info:
Can be grown from seed and transplanted, or root division
Seeds per Gram: 250
Space between rows: 5 cm (2")
Space between seeds: 0.5 cm (1/4")
Depth: 1 cm (1/3")
Germination: 10 days
Germination and Transplant: 30-35 days
Transplant and Harvest: 55 days
Transplanting Distances:
Between Rows: 10 cm (4")
Between plants: 8 cm (3")
Plants per m^2: 101

Culinary Uses: Chives grow in clumps like very small onions, and are harvested by cutting off a section of the green foliage. Chives also produce flowers that are highly prized in cooking.

Medicinal uses:
Safeguards health and wards off disease.
Natural antibiotic.
Reduces high blood pressure.
Reduces indigestibility of fats so use with fatty foods.

Insect repellent:
Chives seem to help protect against aphid attack. They are often planted with roses to increase health and aroma of roses. Often used with cabbages and brassica vegetables to reduce aphid attack. It is a good companion plant to add to a grower.

Echinacea

(Echinacea angustifolia)

The roots and flowering tops are used for detoxifying the body and enhancing the immune system. The root is used as an antibiotic and an immune system booster.

Plant Info:
Propagated by seed or root division.
Space between rows: 20 cm (8")
Space between seeds: 20 cm (8")
Depth: 1 cm (1/3")
Germination: 14 days
Harvest: 60 days

Medicinal uses:
Antibiotic, antiviral and anti-inflammatory.
Given for colds and flu, sore throat, and first sign of cold.
Good for internal infection.
Good for arthritis.
Used for relieving allergies.
Used for skin infections

Native Americans used echinacea for sore throat and snake bite. Root with more "tang" is said to be more powerful.

Allergy Remedy: Echinacea tea is mixed with local honey and lemon. Drink at least two cups a day for a week or through the allergy season.

Echinacea Tea: Two or three springs of Echinacea steeped in hot water for five minutes. Can be used with peppermint for sleep, or lemon and honey for colds.

Feverfew
(Chrysanthemum parthenium)

Flowering tops are used for migraine headaches and arthritis.

Planting Info:
Can be propagated from seeds, root division or cuttings.
Space between rows: 20 cm (8")
Space between seeds: 20 cm (8")
Depth: 1 cm (1/3")
Germination: 14 days
Harvest: 60 days

Medicinal uses:
Migraine headaches.
Arthritis and muscle tension.
Eliminates worms.
Increases fluidity of lung and bronchial mucus.
Used to reduce fever.

Migraine headaches:
Feverfew is widely claimed to be a strong aid in reducing the pain and severity of migraine headaches. Tea should be drunk daily to prevent headaches from occurring, and then used as a tea and compress when headache does occur.
Migraine sufferers should also look at diet and try eliminating chocolate, cheese, onions and dairy products to see if one might be causing the headaches.

Feverfew Tea:
Two or three sprigs of feverfew steeped in hot water for five minutes. Can be used with peppermint. Use daily to prevent headache from occurring. When headache occurs lay in dark room with eyes closed, and drink tea. Use tea in hot or cold packs against back of neck, eye sockets and temples.

Horehound

(Marrubium vulgare)

The leaves are used fresh or dried. It is also used as a tea, mostly for cough and breathing problems.

Planting Info:
Grown from seed or by dividing roots.
Space between rows: 30 cm (12")
Space between seeds: 30 cm (12")
Depth: 1 cm (1/3")
Germination: 14 days
Harvest: 60 days

Medicinal uses:
Used to solve respiration problems.
A cough suppressant.
Used for asthma.
Loosens mucus and helps remove it from the body.
Normalizes heart rhythm.

Cold Preventative:
Horehound is used at first sign of cold. Pour boiling water over about 20 leaves, sweeten with honey.

Horehound Tea: Two or three sprigs of horehound steeped in hot water for five minutes. Said to be first tea to use when starting to feel a cold. Add honey to sweeten.

Harvest: Cut back all new growth and the plant should continue to produce for several years.

Lavender

(Lavandula officinalis)

The flowers and leaves are used for antiseptic. It is also an excellent plant to use as an insect spray, and is used in clothes to prevent moth attack.

Planting Info:
Lavender can be grown from seed, divided or grown from cuttings.
Space between rows 20 cm (8")
Space between seeds: 20 cm (8")
Depth: 1/4"
Germination: 14 days
Harvest: 60 days

Medicinal uses:
Antibacterial and antiseptic.
Calming effect.
Used to fight insect infestations such as head lice.
Used in bath to relieve pain of sore muscles.

Lavender Oil: Fill a glass jar with lavender blossoms and then add olive oil. Place in a sunny place for 4 to 6 weeks.

Lavender sugar: Mix lavender blossoms and sugar in a jar and mix in more fresh lavender every few days. Crush lavender to increase flavor.

Lavender bath: Add a cup full of fresh lavender to a bathwater.

Herbal pillow:
Lavender flowers can be dried and stuffed into a pillow for repelling insects.
Live lavender has a wonderful aroma, and can be placed where it will be slightly brushed during day.

Lemon Balm

(Melissa officinalis)

Dried and fresh flowers and leaves are used as a tonic to raise spirits.

Planting Info:
Can be propagated by seeds, cuttings or by dividing roots.
Space between rows: 30 cm (12")
Space between seeds: 30 cm (12")
Germination: 14 days
Harvest: 70 days

Medicinal uses:
Used for skin disorders.
Used to promote sleep.
Antiviral, used for cold sores.
First aid for cuts and stings.
Said to improve memory and longevity.

Sleep Tea:
Three sprigs of lemon balm, three sprigs of marjoram and three teaspoons of chamomile flowers. Steep in hot water for five minutes. Sweeten with honey and drink before bedtime to prevent insomnia.

Herb Pillow: Make a muslin pillow of crushed lemon balm leaves, thyme and rosemary leaves. Said to promote a good nights sleep.

Poultice: Pour 1/2 cup of water over 1 cup of lemon balm leaves and flowers. Place cloth filled with wet leaves over injured area. Replace as desired. Use for cuts and stings.

Mint
(Menthe verdte)

Mint leaves and sprigs are used for flavorings and a very popular tea. Good addition to fruit, lamb or pork. Mint sauce can be used for meat, chocolate, and ice cream.

Planting Info:
Grown from seeds or cuttings.
Space between rows: 30 cm (12")
Space between seeds: 30 cm (12")
Depth: 1 cm (1/4")
Germination: 14 days
Harvest: 60 days

Medicinal uses:
Used for colds and breathing problems.
Used with chamomile for a restful sleep.
Used to reduce nausea or stomach problems.
Reduces nervousness and stress.
Helps digest food and increase appetite.
Used as an antiseptic or to repel insect attack.

Peppermint Tea: Two to three fresh sprigs of fresh leaf in hot water and steeped for five minutes. Often good at the first sign of illness.

Mint leaves can be added to bath water to relieve and refresh tired limbs. It can be used as a face freshener to remove grease or surface dirt.

Fresh mint leaves can be used as a garnish on food, or crushed and used for flavor. There are several mint varieties such as spearmint and peppermint.

Pennyroyal
(Mentha pulegium)

The leaves and stems are used fresh or dried. It is also used as a tea, and has been used from ancient times to purify water.

Planting Info:
Propagated by seed or cuttings.
Space between rows: 15 cm (6")
Space between seeds: 15 cm (6")
Depth: 1 cm (1/4")
Germination: 14 days
Harvest: 60 days

Medicinal uses:
Settles the stomach.
Used for skin disorders.
Used for headache due to colds and flu.
Used as a mosquito repellant.

Rat and Mice repellent: Pennyroyal seem to help protect against rats and mice. It can be planted near food storage areas to detract pests.

Pennyroyal Tea: Two or three sprigs of Pennyroyal steeped in hot water for five minutes. Said to be good for depression.

Live plant is known to repel fleas and other insects. Scatter plants in the garden, or use around animal pets that might attract fleas. Dry herb can be added to pet bedding.

Caution: Pennyroyal should not be used by pregnant woman as it can effect uterine muscles.

St. John's Wort

(Hyperium perforatum)

Flowering tops are used to counter depression and it also may help viral infections.

Planting Info:
Space between seeds: 30 cm (12")
Space between rows: 30 cm (12")
Germination: 14 days
Harvest: 60 days
Depth 1 cm (1/4")

Medicinal uses:
Given to treat depression.
Antiviral, being studied in treating AIDS.
Tonic for nervous disorders, menopause and female hormones.
Used for ulcers.
Used for bacterial infections internal and external.

Cold Preventative:
St. John's Wort is used at first sign of a cold. Crush 20 leaves, mix with honey and eat.

St. John's Wort Tea:
Two or three springs of St. John's Wort steeped in hot water for five minutes. Used as a digestive tonic and for depression. Add honey to sweeten.

Caution: St. John's Wort may cause allergies. Soak some tea on a band aid and keep on skin for two days

Yarrow

(Achillea millefolium)
Leaves, stems and flowers are used fresh or dried. It is also used as a tea, to counteract the beginning of a cold.

Planting Info:
Grown from seed.
Space between rows: 30 cm (12")
Space between seeds: 30 cm (12")
Depth: 1 cm (1/4")
Germination: 14 days
Harvest: 60 days

Medicinal uses:
Anti-inflammatory.
Stops internal bleeding.
Mild diuretic.
Lowers blood pressure.
Reduces fever.
Used to cover wounds and stop bleeding.
Used for varicose veins
Used on bruises to reduce color.

Skin Care:
Yarrow is famous for helping on skin disorders such as dandruff, acne, and chapped skin. It is also used to prevent infection on existing wounds and sores.

Yarrow Tea:
Two or three springs of yarrow steeped in hot water for five minutes. Said to be first tea to use when starting to feel ill. Also good for any wounds or bleeding problems. The tea is quite bitter so you may want to add peppermint and honey.


1220.
SAGE

11. Culinary Herbs

Many herbs are used to flavor our foods. In hydroponics, we can grow the green foliage type of culinary herbs such as parsley, marjoram and cilantro.

Most culinary herbs can be raised from seed or by cuttings. Some herbs like basil root easily from cuttings and can be grown very quickly by using this propagation method. Most herb seeds are small and require a significant time to germinate sometimes as much as two weeks. Cuttings only take a few days.

Many culinary herbs also have medicinal values. Some, such as fennel, help make fats in food more digestible.

For most herbs, only one or two plants are required for a family. So all the culinary herbs can be grown in a single bed grower or a tub system. They are a beautiful addition to a kitchen and add excellent flavor to most dishes.

Most culinary herbs can be harvested by cutting a few sprigs from the plant and the plant can go on to live a year or more. The plants can get quite large if left alone so they should be pruned occassionally. The cuttings can be used to produce new plants.

Several culinary or medicinal herbs can also be grown in the corners of bed growers to discourage insect attack. These include yarrow, chives, fennel, mint, cilantro, and caraway.

Basil

(Ocimum basilicum)

Basil is grown and then harvested for green leafy portions. The basil leaves are used in a wide variety of cooking and have medicinal uses as well.

Planting Info
Can be grown from seed or from cuttings.
Space between rows: 30 cm (12')
Space between seeds: 30 cm (12')
Depth: 1 cm (1/3")
Germination: 7- 14 days
Harvest: 60 days
pH 5.5-6.5
Temperature 20-24°C (68-75°F)

Floating Bed Culture: Basil can be grown from floating beds and is a fast growing herb, suitable for commercial sales.

Basil is a highly flavored herb that grows very quickly in hydroponic culture. It is used as a seasoning in vegetable dishes, soups, salad dishes and sauces. Pesto sauce is made of basil.

Fresh basil leaves can be boiled and eaten like spinach. They can also be added to any stew. They are a common addition to a fresh garden salad, and are the main ingredient in pesto.

Basil plants may help keep flies away from indoor areas.

A basil plant will continue to grow as it is being harvested but will eventually become woody and may need to be replaced. As it grows pinch back the flowering tips to maintain green growth.

Cilantro

(Coriandrum sativum)
(also Coriander)

The seeds are used as a culinary flavoring for pickles, soups and broths. Leaves are used as Cilantro to season dishes such as salsa.

Planting Info:
Directly Seeded
Seeds per Gram: 250
Distance between rows: 10 cm (4")
Distance between seeds: 5 cm (2")
Depth: 2 cm (2/3")
Germination: 17 days
Germination and Harvest: 60
Plants per m^2: 162

Cilantro is used as a flavoring in many Mexican dishes such as salsa.

Cilantro is a fast growing herb in hydroponics and can be so root dense that a plant near a drain can plug the drain area.

Coriander

Medicinal Uses:
Often used for stomach and digestive problems such as cramps and bloating.

Coriander is the seed portion of a cilantro plant. It is often ground and used in vegetable or meat dishes.

Dill

(Anethum graveolens)

Seeds, stems and leaves of dill are all used for flavoring.

Planting info:
Grown from seed or from cuttings.
Space between rows: 30 cm (12")
Space between seeds: 30 cm (12")
Depth: 1.5 cm (1/2")
Germination: 14 days
Harvest: 60 days

A live dill plant in the eating area is said to increase appetite, so it is a good choice for growing in a dining area. Dill is harvested from growing leaves and it will continue to grow as long as it is harvested.

Dill leaves are used in rice, salads, sauces, egg dishes and noodles.

Dill seed is used in pickles, sauerkraut, stew, salad dressings, butter, breads and fish and chicken dishes.

Medicinal uses:
Used in ancient Babylonia as an astringent
Used to disinfect wounds.
A good preservative and good at fighting bacteria.
Used to reduce nausea and stomach problems and gas.
Mild diuretic and used for bad breath.

Dill Tea: made from two to three springs of fresh leaf or 1/4 teaspoon of seeds steeped five minutes in hot water.

Fennel

(Foeniculum officinale)

Fennel seeds, roots, stems and leaves are used for seasoning. It is also used as a medicinal herb.

Planting Info:
Must be started from seed.
Space between rows: 25 cm (10")
Space between seeds: 25 cm (10")
Depth: 1 cm (1/3")
Germination: 14 days
Harvest: 110 days

The root is used in salad or steamed and served hot. It also is said to break down oily and fatty foods so dieters use it. Dieters also chew on fennel to reduce hunger pains.

The stems are used like celery. They are first stripped of their skin and seasoned. The stalks are also added to a fire under cooking.

The leaves are used as a seasoning in salads stews and vegetable dishes. It is said to make oil and fat more digestible.

Medicinal uses:
Appetite suppressant so used in dieting.
Good for digestive and elimination disorders.
Clears lungs and used as eyewash.

Fennel Tea: Two to three fresh sprigs of fresh leaf in hot water and steeped for five minutes. Excellent choice after heavy food meal.

Marjoram

(Origanum majorana)

Leaves are used for seasoning in tomato, carrot, cauliflower, and spinach dishes. Sprigs are often added to a fire to impart flavor to the food above.

Planting Info:
Grown from seed or cuttings.
Space between rows: 30 cm (12")
Space between seeds: 30 cm (12")
Depth: 1 cm (1/3")
Germinate: 14 days
Harvest: 60 days

Used as a powdered herb in the kitchen for soups, stuffings and sauces. It can be added to vegetables during cooking. It can also be added to breads and scones.

Medicinal uses:
Used by Hippocrates as an antiseptic.
Used for dizzy spells.
Reduces hair loss.
Chewing leaves relieves tooth pain.

Oregano

Wild marjoram (O. vulgare) also called oregano, is preferred for medicinal use. Oregano will grow taller and larger than marjoram and should be given about 50 cm in space.

Marjoram Tea: Four to five fresh sprigs of fresh leaf and flower in hot water and steeped for five minutes. Often good at the first sign of illness.

Parsley

(Apium petroselinum)

Parsley is a biennial herb known for the flavorful taste it gives to potatoes and sauces.

Planting Info:
Grown from seed and transplanted
Seeds per Gram: 780
Space between rows: 5 cm (2")
Space between seeds: 0.5 cm (1/4")
Depth: 0.5 (1/4")
Germination: 15 days
Germination and Transplant: 22-25
Transplant and Harvest: 75 days
Transplanting Distances:
Between Rows: 15 cm (6")
Between plants: 12 cm (5")
Plants per m^2: 45

Culinary Uses: Parsley is often used in cooking as a garnish on the side of a plate. Parsley is used in soups, tossed green salads, coleslaw, breads, butter sauces, tomato and meat sauces, stuffings, meat and poultry.

Medicinal uses:
A diuretic that helps reduce fluid build up or bed-wetting.
Contains iodine so used for goiter.
Excellent breath mint.
Very vitamin rich.

Parsley Tea: Four to five fresh sprigs in hot water and steeped for five minutes. Make tea for bladder problems or water weight gain.

Harvest: Begin harvesting the leaves when they are well developed. Cut the outer leaves, leaving the center of the plant to produce new growth.

Sage

(Salvia officinalis)

Sage leaves are used in a wide variety of cooking and have medicinal uses as well. Sage is also used as a tea.

Planting Info:
Can be grown from seeds or cuttings.
Space between rows: 30 cm (12")
Space between seeds: 30 cm (12")
Depth: 1 cm (1/3")
Germination: 14 days

Sage is harvested from growing stems and will continue to regrow as long as it is harvested. A sage plant can live for several years.

It is a culinary herb that is used in dressings and in poultry. It can be used to flavor breads and cheese dishes as well.

Medicinal Uses:
Antiseptic and astringent
Digestive tonic and stimulant
Hormonal stimulant
Asthma remedy
Used for hot sweats in menopause.

Use the fresh leaves on insect bites and stings. Leaves can also be used as a toothbrush, removing plaque and stains and refreshing gums.

Cosmetic Uses:
Sage is also used as a hair darkener. A handful of sage is boiled in water for an hour or more, then used on hair as a rinse.

Thyme
(Thymus vulgaris)

Leaves are used in a wide variety of cooking and have medicinal uses as well. Thyme is also used as a tea.

Planting Info:
Can be grown from seed, transplanted, or roots can be divided.
Seeds per Gram: 2000
Space between rows: 5 cm (2")
Space between seeds: 1 cm (1/3")
Depth: 0.5 cm (1/4 inch)
Germination: 12 days
Germination and Transplanting: 30-35
Transplanting and Harvest: 75
Transplanting Distances:
Between Rows: 17 cm (7")
Between plants: 17 cm (7')
Plants per m^2: 28

Thyme is used to flavor vegetable juices and salads. It is also used for fish and meats. It is a common ingredient in cheese dishes.

Thyme is also a major culinary herb, used as a ingredient in many types of breads, soups, and vegetable dishes.

Medicinal Uses:
Antiseptic
Chest infections
Bronchitis

Harvest: Thyme is harvested from growing stems and it will continue to regrow as long as it is harvested. A Thyme plant can live for over a year.

12. Salad Vegetables

Salad vegetables include lettuce, spinach, watercress, tomato, cucumber, bell pepper and onion. The salad vegetables are usually eaten raw in a salad or in sandwiches. They are also used for salsas and garnishes for many dishes.

Since salad vegetables are eaten raw, care must be taken to ensure no contamination is received from any microbes or bacteria. This means organic nutrients should be carefully applied and used only after composting to reduce the possibility of spreading salmonella and other soil born diseases. Or use inorganic hydroponic nutrients for the salad vegetables.

When growing for home use, salad vegetables should be eaten very soon after picking to ensure higher amounts of vitamin A and C. Fresh foods also have disease-fighting properties. The National Cancer Institute of the US is recommending five fresh fruits and vegetables a day to reduce the threat of cancer.

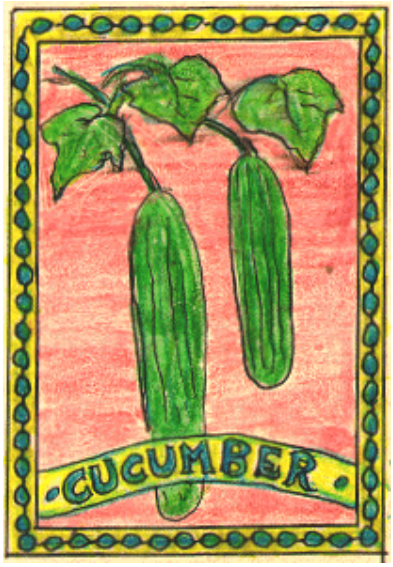
Salad vegetables, such as lettuce, tomato, bell pepper, watercress, cucumber and spinach, are some of the most popular foods grown in hydroponics. They all are fast growing and the fruits contain a high percentage of water (from 80 to 90% water). This means that there is a large volume of weight produced for the amount of time and nutrient supplied.

Salad vegetables also tend to be highly prized as a commercial commodity and thus can often be sold to neighbors or through marketing. Often salad vegetables can be sold or traded for other necessary foods such as wheat, soybeans, corn or other slower growing field crops.

Cucumber

(Cucumis sativas)

Planting Info:
Directly Seeded
Seeds per Gram: 250
Space between rows: 30 cm (12")
Space between seeds: 30 cm (12")
Depth: 3 cm (1.25")
Germination: 5 days
Germination and Harvest: 70
Plants per m^2: 11



Cucumber is a vine crop that can be very prolific. Just two plants in a tub will take over whatever corner they are in and will vine up all over the space. They are best placed where the tops can reach an eave of the greenhouse and they will produce two to three cucumbers a day.

When grown, cucumbers need a vine support to keep them suspended in the air, and this support should be quite strong. Pinch out the top of the cucumber plant when they reach the top of the growing area.

Pinch out the tips of lateral branches two leaves beyond where the fruit has formed.

Most varieties have male and female flowers and have to be pollinated by hand. This is accomplished by using a paintbrush from the middle of each flower. The female flowers have a bump behind the flower. The take pollen from the male flowers and paint inside the female.

Nutrients: This plant is a heavy feeder and can produce with organic materials. Composted materials

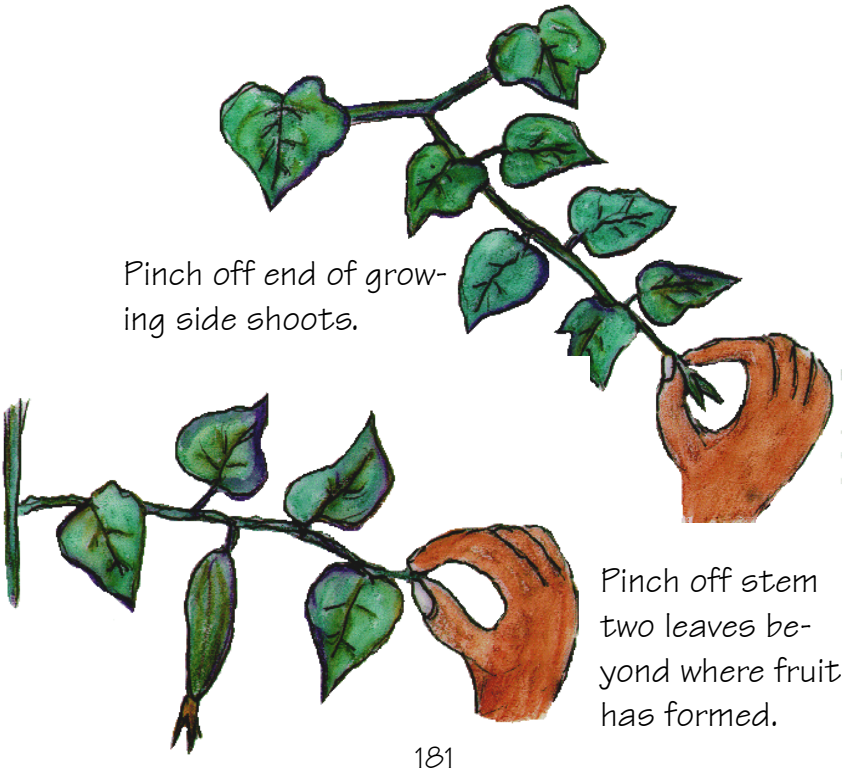
or a "tea" of manure and water should help. Whatever the source, cucumbers require high amounts of nitrogen.

Pests: Aphids, cucumber beetles, leafminers, pickleworm, squash bugs, and squash vine borers.

Diseases: Bacterial wilt, downy mildew, mosaic, powdery mildew, scab, and stem anthracnose.

Harvest: Once the cucumbers start to form they will grow and mature rapidly. Keep a close watch on them at this point, because overmature fruit left on the vine will cause the plant to stop producing. Pick and discard any overmature or yellow cucumbers. Generally, the fruit will be a dark green and get lighter towards the blossom end. Pick the fruit before this blossom end begins to soften.

Pruning and Trimming Plants



Lettuce
(Lactuca sativa)

Planting Info:
Can be Transplanted
Seeds per Gram: 1086
Space between rows: 5 cm (2')
Space between seeds: 1 cm (1/3")
Depth: 0.5 (1/4")

Floating Bed Lettuce
Germination: 5 days
Germination and Transplant: 15-18
Transplanting and Harvest: 45
Transplanting Distances:
Between Rows: 17 cm (7")
Between plants: 17 cm (7")
Plants per m^2: 28

Media Bed Lettuce
Germination: 5 days
Germination and Transplanting: 20-22
Transplanting and Harvest: 55
Transplanting Distances:
Between Rows: 20 cm (8")

Lettuce leaves are commonly used in salads and sandwiches. They are also part of the filling for tacos, and a wide variety of traditional dishes.

There are two basic types of lettuces, head lettuces and cos lettuce.

Head lettuces - (Lactuca sativa) in these varieties, the leaves form into a head in the center of the plant. Many of these are difficult to grow in hydroponics, and the excess moisture can cause rot to begin inside the head.

Cos lettuces - (L. Sativa longifolia) are characterized by a leafy plant that continues to grow as it is being harvested. Cos lettuces are often used in hydroponic culture because plants are harvested by picking leaves.

This harvest method can produce eight times as much green leafy vegetable as harvesting a whole plant.

Lettuce uses less light than most plants. Providing some sort of shade may be necessary. This may be as simple as setting up a fine mesh netting over the plant. Lettuce need to have steady and rapid growth.

Pests: Aphids, cabbage loopers, cutworms, flea beetles, leafminers, slugs, and snails.

Diseases: Lettuce rot.

Harvest: If you have planted heading lettuce, it does not necessarily have to head up to be harvested. Go ahead and pull up the whole plant and eat it. If you have planted a loose-leaf lettuce harvest the tender outer and lower leaves as they are needed, leaving the plant in the ground to mature more leaves. For maximum crispness, harvest lettuce in the morning after the plant has had the benefit of a cool moist night.

Bolting: Bolting is when lettuce will start to grow through the center of the plant. It is trying to go to seed. At this point the leaves become bitter and the plant is no longer sellable. The leaves can still be used for stews and soups. Bolting occurs because of plant stresses, warm temperatures, lack of nutrient, lack of water. Lettuce should be shaded in very hot weather to reduce bolting.

Tip burn: The margins of the leaf turn brown and look dead. This is caused by a calcium deficiency at the tops of leaves and it usually happens in sunny weather. It can usually be reduced by shading plants to reduce water use, diluting the nutrient solution to 1/2 strength in sunny weather, or adding calcium nitrate to the solution.

Peppers

(Capisium Fruitescens)

Planting Info:
Can be Transplanted
Seeds per Gram: 160
Space between rows: 8 cm (3")
Space between seeds: 1 cm (1/3")
Depth: 1 (1/3")
Germination: 12 days
Germination and Transplanting: 35-40
Transplanting and Harvest: 80
Transplanting Distances:
Between Rows: 35 cm (14')
Between plants: 30 cm (12")
Plants per m^2: 8
pH of 6.0-6.5
temperatures from 18-28°C (64-82°F)

Bell peppers are a tropical plant that can live to be seven years old. A bell pepper plant will produce eight to ten peppers at a time, and as many as 60 peppers can be produced by a bed grower, enough to supply one or two a day.

Bell peppers form flowers that later turn into peppers. The peppers form as a green bell shape, and can be picked green. As they ripen further they will turn yellow or red, depending upon the type. Red peppers have ten times the vitamin C as the green peppers, and so they are more nutritious fully ripened.

Hot pepper are grown just as bell peppers, but must be kept away from bell peppers or the bell peppers will become hot as well.
Peppers need humidity over 50% or the blossoms will drop off plant and fruit will not form.

Nutrients: Too much nitrogen can cause blossoms or young fruit to drop off of the plant.

Spinach
(Spinacia spinosa)

Planting Info:
Can be Transplanted
Seeds per Gram: 100
Space between rows: 5 cm (2")
Space between seeds: 2 cm (2/3")
Depth: 1 cm (1/3")
Germination: 8 days
Germination and Transplanting: 18-22
Transplanting and Harvest: 75
Transplanting Distances:
Between Rows: 17 cm (7')
Between plants: 17 cm (7")
Plants per m^2: 28
pH 6.0 to 7.0

Spinach is a green leaf vegetable that is used fresh in salads or boiled and served as a vegetable.

While spinach has a reputation for being excellent for health, it can be a mineral robber in the diet. This is because spinach can store calcium in the form of oxalic acid. While this would appear to be a good thing, we all need calcium, the oxalic acid cannot be digested and actually robs the body of minerals already there. Therefore, spinach should be eaten occasionally, or replaced by greens such as mustard or turnip greens.

The Spinach leaves can easily rot if the overpour water does not drain properly, so when they are about 3" tall, start pouring into the media, no longer over the plants. Also, when the leaves get too tight on top the plant can start to rot within. Harvest leaves in such a way that remaining leaves have some space from other leaves.

Common Spinach - Spinacia spinosa is a bushy plant made up of dark green ruffled and pointed leaves. Spinach does best in spring and fall seasons and has a tendency to bolt in the hot summer months. Spinach can often be kept from bolting in the summer by keeping the media moist. Also common spinach can be replaced by New Zealand Spinach in the hotter seasons and climates.

New Zealand Spinach - Tetragonia expansa creates stems of leaves that can reach two feet long. It does better in the hotter summer season than common spinach. New Zealand Spinach is not a true spinach, but is used in recipes in the same way.

Pests: Aphids, european corn borers, flea beetles, leafminers, and whiteflies.

Diseases: Blight and downy mildew.

Harvest: Leaves can be harvested, leaving the plant in the ground to put on new growth.

Note: There are good substitutes for spinach in hydroponics. Turnip greens and beet greens can be used like spinach, boiled as vegetable greens. Both have an edible root which makes them a better candidate for family food.

Spinach is a fast growing commercial crop in hydroponics and can be used for family income.

Tomato
(Lycopersicon escullentium)

Planting Info:
Grown from seed and transplanted
Seeds per Gram: 320
Space between rows: 8 cm (3"
Space between seeds: 1 cm (1/3")
Depth: 1 cm (1/3")
Germination: 6 -10 days
Germination and Transplant: 18-20
Transplanting and Harvest: 65
Transplanting Distances:
Between Rows: 35 cm (14')
Between plants: 30 cm (12")
Plants per m^2: 8

Tomato is one of the most popular garden vegetables worldwide. It is a part of many diets, and tomato sauces, salsa's and ketchup's are some of the best selling food products.

Tomato plants can grow 25 feet long in hydroponic systems and produce for over a year. While soil based tomatoes usually produce about seven pounds a year, a hydroponic plant can produce 32 pounds or more.

There are two type of tomatoes, determinant and indeterminate.

Determinant plants are bushy and produce several tomatoes all at once.

Indeterminate plants tend to vine and produce tomatoes as they vine, so they can produce tomatoes year round. Indeterminate plants are most often used in hydroponic culture.

As the plant grows, it will require support for the vines and fruit. Usually the plant is loosely tied with a string to a support trellis or stake They can also be tied with twine to a support above.

As the plant grows, it will produce suckers in between the leaves at each node. To keep the plant growing upward, it is important to pinch out the suckers as they reach about one inch long. As the fruit starts to form, leaves under the fruit can be removed as no longer necessary. Keep leaves over the fruit to keep tomatoes shaded as they ripen.

Tomato plants will produce a stem with flowers, usually every third node on the plant. These tomato flowers are self pollinating, but they need to be vibrated or shook slightly everyday to ensure they become pollinated. After the flowers die off, those that have been pollinated will form in the remaining flower stem.

When the tomatoes get to be about one inch in diameter, pick off the smaller fruit and leave only three on each stem. This helps the tomatoes on the stem get larger and more flavorful. If a larger tomato is desired, leave only one fruit on each stem.

Tomatoes produce best at daytime temperatures of 25°C (77°F) and nighttime temperatures of 18°C (65°F). Over 32°C (90°F), the plant is stressed by heat and there is poor fruit set.

Tomato flavors are from several things. The type of tomato plant will determine some of the flavor. Most modern hybrid plants are designed to look nice and keep well, but not necessarily for flavor. Some tomatoes with great flavor are the heirloom varieties. There are also many varieties worldwide, and these international varieties often have high flavor.

Flavor will be improved when the tomatoes are allowed to ripen on the vine. Many supermarket tomatoes are picked green and shipped to your local market, so the tomatoes were not allowed to ripen on the vine. Each tomato should be picked just before it is eaten.

Nutrients also affect flavor, and at this point you can experiment to find the best flavor recipes for your tomatoes. Nutrient can be reduced a few days before the tomatoes are to be picked. This starvation allows the tomato to build up more sugar and less nitrates. Also, a saltier solution will improve flavor by also starving the plant somewhat. Ph can be lowered to under 6.0 by adding vinegar to the nutrient water.

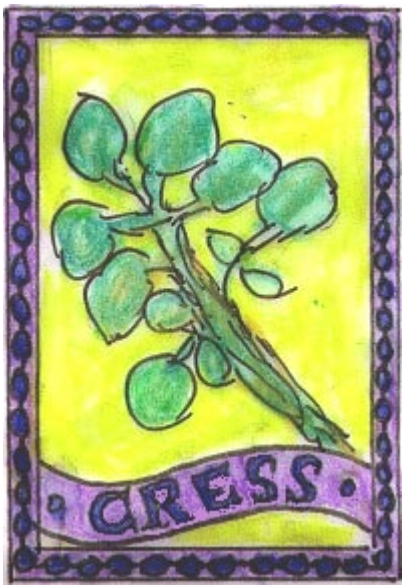
Blossom end rot - Blossom end rot is a brown discoloration at the end of the tomato that begins to rot before the tomato ripens. It is usually a sign that the tomato is low on calcium, and calcium can be added by making a spray with calcium nitrate, or other calcium based product.

Cracking of splitting fruit - this is often caused by sudden changes, and often is from the tomatoes getting wet during the hot day. It can also be from rapid changes in the nutrient solution.

Greenback - A tomato fails to ripen near the stem, or fruit does not set. Several conditions can cause this including too much nitrogen fertilizer, nighttime temperatures over 70^0 F, low temperatures below 50^0 F, irregular watering, insects such as thrips. Plants need 8-10 hours of direct sunlight daily. Any less direct sunlight will result in a spindly growing, nonproductive plant with healthy foliage.

Water-cress

(Nasturtium officinale)



Planting Info:
Can be seeded or reproduced from cuttings.
Space between rows: 10 cm (4")
Spacebetween seeds: 10 cm (4")
Germination: 5-8 days

A small green leafy vegetable that is very high in vitamins and minerals and has antibiotic constituents.

Watercress grows if it is placed in small plastic containers using the floating system but without the need for styrofoam. Only the root enters the water, and the plant floats above.

Watercress leaves can be used in salads, sandwiches, soups and stews. They can also be boiled and served as a vegetable, but this reduces some of the food value. They should be picked fresh and eaten within one half hour from being picked to retain full food value. Watercress contains vitamins A, B_1, B_2, C and E as well as iodine, iron and phosphorus. It is perhaps the richest source of minerals in the diet.

Peppercress - is a peppery flavored watercress that is used in gourmet cooking.

Caution: Do not use contaminated seeds from dirty water.

More info: Resh, H. 1998, Watercress in Hydroponics, Practical Hydroponics Issue 38 January/February 1998.

Celery

(Capium graveolens)

Planting Info:
Can be Transplanted
Seeds per Gram: 2500
Space between rows: 5 cm (2")
Space between seeds: 0.5 cm (1/4")
Depth: .5 cm (1/4")
Germination: 20 days
Germination and Transplanting: 30-35
Transplanting and Harvest: 95
Transplanting Distances:
Between Rows: 20 cm (8 in)
Between plants: 20 cm (8 in)
Plants per m^2: 21

Celery is grown for the green bunching stalks, and for the celery root. The leaves can also be used to flavor soups and stews.

Celery may be easier to sell if it is a whiter color. It can be blanched (or made whiter) by covering the stalks in a paper bag or burying under media. If the sun is restricted the stalks will turn white, otherwise they will turn green.

Pests: slugs and snails, celery and carrot fly.

Diseases: Cucumber mosaic virus, celery heart rot and celery leaf spot.

Celery can show signs of boron deficiency. Add one teaspoon of borax to 12 gallons of water.

Celery can be grown in a floating bed grower and makes an excellent commericial crop to sell in stores. If cultured in floating beds it will not develop a sellable root.

Root vegetables and tubers section includes potatoes, leeks, sweet potatoes and onions.

A single two square foot tub provides about one half ounce of ginger root each week.

13. Root Vegetables

Root vegetables and tubers, such as potato and sweet potato, can also be grown in hydroponics. This important part of the diet can be very productive in deep media hydroponic growers.

Roots will need more space to grow under the surface so media growers for roots are constructed at least 30 cm (12") deep. The media should be deep enough to keep the root area in a environment that is not saturated with water, but still kept moist.

Root vegetables can be a part of everyday diet. A soup can be made with soybeans and fresh vegetables from the garden. A basic soup that includes a cup of cooked soybeans should provide each family member with about 400 calories, and about 1/2 of the protein required for the day.

Potatoes were one of the first crops grown by Gericke, the modern day father of hydroponics. He grew a fine crop of potatoes under his tomato plants in a California greenhouse. Potatoes are very high is carbohydrates and provide daily energy.

Many root vegetables can also be kept through the winter or slower growing season by harvesting and storing or drying. They can also be kept alive in the hydroponic beds if the temperatures can be kept above freezing. Even in the northern temperate climates the root vegetables can stay alive through the 8 hour sun days, although don't expect much growth.

Many root vegetables take a longer to grow, sometimes as much as 120 days to harvest. Many, such as carrots, cannot be transplanted. This means that the areas of the grower which are being harvested should be replanted as soon as possible to keep a supply of roots from the garden.

Beets

(Beta vulgaris)

Planting Info:
Can be seeded or transplanted
Seeds per gram: 50
Directly seeded
Space between rows: 15 cm (6")
Space between seeds: 10 cm (4")
Germination: 10 days
Germination and Transplant: 20-25
Harvest: 60 days
Depth: 3 cm (1.25")
Seed for Transplant:
Space between rows: 8 cm (3")
Space between seeds: 1 cm (1/3")
Depth: 1 cm (1/3")
Plants per m^2: 54

Beets form over the top of the media so they can be grown in a 5" deep bed grower. Each beet seed pod contains about three seeds so the young seedlings may have to be thinned.

Beet roots also have edible greens so the entire plant is useful. They grow well in hydroponics and can be harvested when about 2" in diameter. Beets can also be grown for winter storage, stored in boxes of dry peat moss.

Pests: Black fly

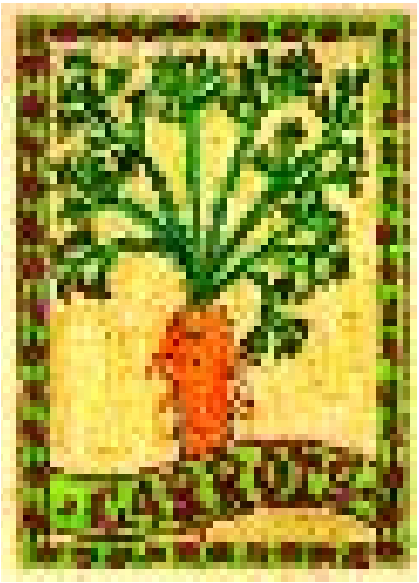
Diseases: Damping off, leaf spot and heart rot.

Harvest: Harvest the entire plant as roots get to be 4 cm (2") diameter. Break off the leaves to reduce bleeding from the beet root. Use in stews or salads.
If beets have black bitter spots they are low on boron. Add 1/6 teaspoon of borax to 2 gallons of water and water the plants.

Carrots

(Daucus carota)

Planting Info:
Directly Seeded
Seeds per Gram: 250
Space between rows: 8 cm (3')
Space between seeds: 10 cm (5")
Depth: 0.25 cm (1/8")
Germination: 18 days
Germination and Harvest: 120
Plants per m^2: 102
pH from 6.0 to 7.0
temperature 40 to 80° F
Yield: 1/4 pound/bed/day



Carrots will need to be grown in a media bed of at least 30 cm (12") deep. The species of carrot used should be one that is shorter, stockier. We recommend Natches as an excellent flavored carrot that is easily grown in hydroponics.

The carrots will press against the media as they grow, and to some degree, pick up the surface texture of the media. So it is best to use a fine media such as sand and avoid coarse media such as pebbles.

A full bed of carrots can be thinned out all winter. Although the carrots will grow very slowly, if at all, they will usually have enough sun to survive.

Pests: Aphids, carrot rust flies, carrot weevil, and cutworms.

Diseases: Leaf blight

Harvest: Start harvesting when they reach the size diameter you like. Reseed in the area you are harvesting, or plant another type of crop.

Garlic
(Allium sativium)

Planting Info:
Live plants transplanted
Space between rows: 10 cm (4")
Space between seeds: 7 cm (2.5')
Depth: 2 cm (2/3")
Germination: 8 days
Germination and Harvest: 120 days
pH from 5.5 to 8.0

Garlic is used as a flavor enhancer in food and as a medicinal herb. It can be planted in any grower as a companion plant to reduce insect attack.

Garlic is grown from cloves of a shallot, and planted 1" deep. Cloves of garlic are rounded on one end and pointed on the other. Gently press the clove into the soil with the pointed end slightly above the soil line.

Garlic is know for many medicinal properties, and is a standard part of the diet of many cultures. It is known to thin the blood and act as an antiseptic. It also adds tremendous flavor. There is research that garlic grown with excess selenium can be used to reduce breast cancers. It is a natural antibiotic and useful in keeping disease away.

Pests: Onion maggots and thrips.

Diseases: Downy mildew, neck rot, pink rot, and smut.

Harvest: Harvest individual plants as needed fresh. Whole bulbs may be stored and individual cloves separated as needed.

Ginger
(Zingiber officinale)

Planting Info:
Planted from root
Space between rows: 40 cm (12")
Space between roots: 40 cm (12')
Depth: 5 cm (2")
Top Growth: 14 days
Germination and Harvest: 120 days
pH from 5.5 to 8.0

Ginger is grown from pieces of the root material that is planted under the media. The Ginger plant looks like a bamboo and once it takes hold, will provide fresh ginger on the edges of the root area of the plant. The plant grows to about 3 foot tall. Since they are very decorative they can be used as a room divider or in a room planter.

Ginger root is a vital ingredient in many dishes from many cultures. It is also used as a medicinal herb, especially prized for stomach disorders. Ground ginger is used in many recipes as well.

Ginger also is helpful in preventing motion sickness and vertigo. It is used to reduce stomach and intestinal gas. It is also used as a candy that is popular with children.

Pests: Onion maggots and thrips.

Diseases: Downy mildew, neck rot, pink rot, and smut.

Harvest: Harvest individual rhizomes from the root area as needed.

Leeks
(Allium porrum)

Planting Info:
Can be Transplanted
Seeds per Gram: 250
Space between rows: 5 cm (2")
Space between seeds: 0.5 cm (1/4')
Planting Depth: 1 cm (1/3")
Germination: 10 Days
Germination and Transplanting: 35-40
Transplanting and Harvest: 80
Transplanting Distances:
Between Rows: 10 cm (4 in)
Between plants: 10 cm (4 in)
Plants per m^2: 81
pH from 6.0 to 8.0 with 6.5 to 7.0 being optimum

Leeks are grown like onions. The leeks form at the base of the plant, and can be picked and eaten when they have a diameter of about 3/4". When plants get to be 3 to 4" tall push extra media around the stem area up to the growing leaves. This will turn the stems white and make them more tender.

Leeks need a night temperature of 55^0 F (13^0C) or greater, and grow best in a daytime temperature of 80^0 (27^0C) or greater. They should receive lots of sun in a warm place in the growing area. Leeks also grow in the winter, but much more slowly.

Pests: Onion maggots and thrips.

Diseases: Downy mildew, neck rot, pink rot, rust and smut.

Harvest: Harvest leeks when the stems are one to two inches in diameter.

Onion

(Allium cepa)

Planting Info:
Grown from seed and transplanted
Seeds per Gram: 250
Space between rows: 5 cm (3")
Space between seeds: 0.5 cm (1/4")
Depth: 1 cm (1/3')
Germination: 10 days
Germination and Transplanting: 30-35
Transplanting and Harvest: 80
Transplanting Distances:
Between Rows: 12 cm (5")
Between plants: 10 cm (4")
Plants per m^2: 67
pH from 5.5 to 7.0

Onions are used with garlic and ginger as the basic flavorings added to food. They are not really roots but part of the allium family. Because they grow above the media they can be grown in a 6" bed grower.

Pests: Onion maggots and thrips. Onions are used in bed growers as a companion plant to repel insects.

Diseases: Downy mildew, neck rot, pink rot, and smut.

Molds and mildew: onions can get molds and mildew. Mold around the root is caused by extra moisture near root. Make sure the water level is lower in the tub, or pour nutrient in a place in the tub where it does not wet the roots. Also, mildew can build up from stale air, so good air ventilation is needed.

Harvest: After the bulbs have reached maturity, place them in an old onion or orange sack. This loose netting will allow air to flow through and finish curing the onions. Hang the sack of onions in a protected area with plenty of ventilation. Onions will keep for several months if left in a dark, cooler place.

Potato

(Solanum tuberosum)

Planting Info:
Directly Seeded
Seeds per Gram: 250
Space between rows: 15 cm (6")
Space between seeds: 15 cm (6")
Depth: 3 cm (1.25')
Germination: 5 days
Germination and Harvest: 70
Plants per m^2: 11
pH from 6.0 to 6.5
Yield: .45 pound/bed/day

Potatoes were one of the first crops ever grown in hydroponics and continue to be one of the most successful. W. F. Gericke, modern day father of hydroponics, reports about 1/2 pound of potatoes a day from a two square meter grower. The grower must be at least 12" deep and media must be piled around the potato at least 4" above the highest potato.

To begin a potato plant, a small potato about the size of a hen's egg is planted. These starter or seed potatoes can be started in a semi light room, with potato eyes set upright and sprouted. The sprouts are planted upright to begin green growth.

The potatoes will grow in the space below, and continue to grow after harvest if you remove the potatoes carefully without disturbing the roots.

Potatoes need about 8" of media to grow under the plant. If the potato tubers get in the standing water they will rot or taste moldy. This is why all potato growers should be at least 12" deep.

Gangrene - If a potato grows to close to the surface it can go green and this must be thrown away.

Sometimes potatoes will bloom and produce a small green tomato-looking fruit. This fruit is also poisonous.

Molds and mildew - potato plants can get molds and mildew. Often the mold around the root is caused by excess moisture too close to the root. This can be remedied by making sure the water level is lower in the tub, or pouring nutrient in a place in the tub where it does not wet the roots. Also, mildew can build up in potato plants because of stale air, and so good air ventilation will help reduce this disease.

Pests: Aphids, cabbage loopers, colorado potato beetles, corn earworms, cucumber beetles, european corn borers, flea beetles, leafhoppers, leafminers, potato tuber worms, and tomato hornworms.

Diseases: Black leg, early blight, internal black spot, mosaic, rhizoctonia, ring rot, scurf, vegetable soft rot, and verticillium wilt.

Harvest: Small young potatoes can be dug up and eaten any time. They are great in a soup with green beans or eaten whole by themselves skin and all. When the foliage starts dying it is time to harvest all remaining potatoes. Lay the potatoes out to dry quickly and then store them in a cool, dry, dark place.

Potatoes can be harvested by reaching under the media and feeling for a larger tuber. It seems the potato puts most of its resources in one or two potatoes that grow very fast. The largest potatoes should be harvested first.

Radish

(Raphanus sativas)

Planting Info:
Directly Seeded
Seeds per Gram: 250
Space between rows: 8 cm (3")
Space between seeds: 5 cm (2")
Depth: 2 cm (2/3")
Germination: 4 days
Germination and Harvest: 30
Plants per m^2: 202

There are summer and winter radishes, and these two crops should be switched during the year to keep radish production going year-round. The winter radishes tend to be larger and have to be in a deeper tub.

Radishes can burst if they have been exposed to water and then rapid drying. Since this is likely in a tub overpour system, it might be wise to put a funnel in the tub and pour water deeper than the developing roots. Radish leaves are usually very soft in hydroponic culture and suitable for use in soups and salads.

If planted among greens, such as turnips or mustards, radishes will serve to deter insects from invading the greens.

Pests: Cabbage loopers, flea beetles, harlequin bugs, Imported cabbage worms, and onion maggots.

Harvest: Radishes can be harvested whenever they reach an eatable size. Spring planted radish takes about four weeks til harvest. The summer and fall varieties take five and nine weeks respectively.

Sweet Potato

(Ipomoea batatas)

Planted from Sprouts
Space between rows: 15 cm (6")
Space between seeds: 15 cm (6")
Depth: 3 cm (1.25')
Germination and Harvest: 70
Plants per m^2: 11
pH from 5.5 to 6.5
temperatures over 60^0 F night

Sweet potato is a root vegetable (tuber) that grows from a trailing vine. It is a tropical root rich in vitamin C and vitamin A.

Sweet Potatoes are a very important source of carbohydrate in the daily diet. They can be cooked as a vegetable or mixed in stews. They also make a great pie which can be substituted for pumpkin. Sweet potatoes have very fragile skins and must be handled carefully. If they are stored in a dry dark place they should keep about 10 weeks.

Molds and mildew - sweet potato plants can get molds and mildew. Often the mold around the root is caused by excess moisture too close to the root. This can be remedied by making sure the water level is lower in the tub, or pouring nutrient in a place in the tub where it does not wet the roots. Also, mildew can build up in potato plants because of stale air, and so good air ventilation will help reduce mildew build up.

Sprouts growing from a sweet potato are called slips. They can be twisted off and planted.

Making slips:

Sweet Potato plants are grown from small plants called slips. These slips can bought commercially or grown at home. To grow your own, place some sweet potato roots in moist sand or sawdust about 3 to 4 inches deep. Keep the soil medium near 27°C (80°F) to sprout. When the small sprouts appear, pull the sprouts away from the roots. Cut about an inch off the bottom of the slips and plant in the garden when all danger of frost is over.

Pests: Flea beetles, sweet potato beetles, sweet potato weevils, and wireworms.

Diseases: Black rot or fusarium wilt.

Harvest: If you plan on storing sweet potatoes, allow them to air dry out of direct sunlight before storing. Extended exposure to sun can scald the tubers.

Turnip
(Brassica rapa)

Planting Info:
Can be seeded directly or transplanted
Space between rows: 10 cm (4")
Space between seeds: 10 cm (4")
Depth: 1 cm (1/3')
Germination: 5 days
Germination and Harvest: 80
Plants per m^2: 81
pH of 5.5 to 7.0
temperature from 65-80° F

Turnips are grown for both their roots and their tops, which are cooked for greens.

Turnips are low in calories and nutrition. They can be stored and added to soups and stews. They have a delicate flavor that pick up the flavor of the stew and without adding much flavor of their own.

Turnips grow above the media surface so they can be grown in a 5" deep media bed.

Hot weather can make the roots bitter tasting and woody in texture. If you are growing the turnips for greens, there is no need to thin the plants. Turnips grown for their roots will need ample space between the plants to develop sizeable roots.

Pests: Aphids, cabbage loopers, cabbage maggots, cutworms, flea beetles, harlequin bugs, imported cabbage worms, and leafminers.

Diseases: Black rot and leaf spot.

Harvest: Start harvesting turnips when they reach 2" in diameter and then continue to harvest as needed.

Table vegetables and stable foods are slower in hydroponic culture than most other vegetables.

Green beans growing in a tub grower. A tub of four bean plants will procuce a handful of green beans every day.

14. Table Vegetables

Many vegetables are eaten as a side dish at a meal, or as a table vegetable. They include green beans, broccoli, cauliflower, chard, chinese cabbage, corn and more.

Staple foods are those foods used as basic survival foods for a culture or group. These include beans, corn, rice, soybeans and wheat. Staple foods are often the seed portion of the plant, making up a small portion of the entire plant. To grow these in hydroponics, a lot of nutrient will be used for parts of the plant that are not eaten.

Table vegetables such as green beans, cabbage, broccoli and cauliflower can also be grown hydroponically. Some of these have lesser food values than others and so selection of the table vegetables may help impact the nutritional value of your family daily diet.

Some table vegetables require a lot of plant material be grown for the amount of food received. This would be true of corn that is only 50% edible. The stalks of the corn carry a valuable sugar substance. Corn syrup is made from the inner stalks of corn.

Squash plants are almost all edible. Native Americans used the blossoms, leaves and seeds for a variety of dishes. The seeds are an excellent source of daily fat requirements.

Beans can be grown in hydroponics with great success. They can be grown for a dry bean or for fresh green beans. The wait is long for a cup of dry beans. You can count on a cup of dry beans per square foot every two months. That is not much return for the work. It is usually better to trade for or buy your grain requirements rather than grow them hydroponically.

Beans

(Phaseolus vlugaris)

Directly Seeded
Seeds per Gram: 250
Space between rows: 15 cm (6')
Space between seeds: 15 cm (6")
Depth: 3 cm (1.25")
Germination: 5 days
Germination and Harvest: 70
Plants per m^2: 36

Broadbeans

Directly Seeded
Seeds per Gram: 250
Space between rows: 20 cm (8")
Space between seeds: 15 cm (6")
Depth: 4 cm (1.75")
Germination: 8 days
Germination and Harvest: 100
Plants per m^2: 27
pH from 6.0 to 6.5

Beans are an important part of the hydroponic diet. Once bean plants are established, they can continue to produce beans for a few weeks. The bean plants will stop producing beans if some pods are allowed to fully mature. Then the plant appears to "see" its reproductive mission accomplished and dies. So it is important to make sure to pick beans before they are matured, or allow all to mature and then pick. Beans can be picked green in the pod and eaten as a vegetable, or allowed to mature and harvested for their bean seeds which can be dried and stored.

For tub systems runner beans or beans that vine, are more suitable for long culture. If you harvest beans every day, there will be a heavier harvest.

Beans are highly productive in hydroponic tubs. It is not unusual to pick an ounce of bean pods from a tub every day. This productivity will slow down in the winter due to day length and so a winter variety may be more suitable, or switch to pea pods.

Nodule Bacteria for beans: Beans have a special node module bacteria that can provide nitrogen for the plant if they colonize the roots. These nodule bacteria will not necessarily be in the hydroponic media and it may pay to inoculate the system with the bacteria. Once the bacteria is established they will reduce the need for nitrogen so the plant must be on low nitrogen nutrient such as Bloom in order to ensure flowering.

Pests: Aphids, bean leaf beetle, cabbage loopers, corn earworms, cucumber beetles, european corn borers, leaf miners and mexican bean beetle.

Diseases: Bacterial blight, bacterial spot, downy mildew, fusarium wilt, mosaic, powdery mildew, foot rot, rust, stem anthracnose and yeast spot.

Harvest: Harvest beans for drying when the pods have become transparent and the beans are well filled out inside.

Harvest: Snap beans or green beans should be harvested before beans mature and pods fill out.

If the plant is being grown for dried beans, the plant should mature and pods should dry out before harvesting.

Broccoli

(Brassica oleracea italica)

Planting Info:
Can be Transplanted
Seeds per Gram: 280
Space between rows: 10 cm (4")
Space between seeds: 1 cm (1/3")
Depth: 1 cm (1/3")
Germination: 7 days
Germination and Transplanting: 20-22
Transplanting and Harvest: 75
Transplanting Distances:
Between Rows: 30 cm 12")
Between plants: 25 cm (10")
Plants per m^2: 11
ph 6.0-7.0
temperature 40-70°F

Broccoli has very little nutrient value in the diet and only a small part of the plant is edible so it is usually grown in small amounts. It does provide all necessary vitamin A and C as well as several minerals.

It is recommended that broccoli for home use be replaced by a root vegetable such as carrot, that has a higher nutrient value and is more productive in hydroponics. This is primarily because of the stem portion of the broccoli that is not edible or sellable.

Harvest: Cut broccoli with a knife about 6" below the clusters of buds. After the main cluster is harvested broccoli continues to produce clusters from the side shoots. It can continue to produce for several weeks. After the flowers open it is no longer edible.

Cabbage
(Brassica oleracea capitata)

Planting Info:
Can be Transplanted
Seeds per Gram: 290
Space between rows: 10 cm (4")
Space between seeds: 1 cm (1/3")
Depth: 1 cm (1/3 ")
Germination: 7 days
Germination and Transplanting: 30-35
Transplanting and Harvest: 90
Transplanting Distances:
Between Rows: 30 cm (12")
Between plants: 25 cm (10")
Plants per m^2: 11
pH 6.0-7.5

Cabbage can be eaten raw, as in cole slaw, or cooked. It has a strong odor that may make it unappealing for some family members. Chinese Cabbage is more productive in hydroponics and might be grown instead.

Cabbage may need some substances from decaying organic material so the growing media should have some organic materials. Or add soil to the media. Cabbage also has a lower iron requirement than lettuce so it can be used as a crop in aquaculture, or fish waste water.

Pests: Caterpillars, cabbage root fly, flea beetles, slugs and snails.

Diseases: Club root, downy mildew, white blister.

Harvest: Pick when white heads are firm by cutting off at the base. The heads should be from 3 to 6 pounds each. For a second crop, cut a cross about 1 cm (1/2") deep in the top of each stump. The greens growing from the stump can then be eaten.

Cauliflower

(Brassica oleracea botrytis)

Planting Info:
Can be Transplanted
Seeds per Gram: 280
Space between rows: 10 cm (4")
Space between seeds: 1 cm (1/3")
Depth: 1 cm (1/3")
Germination: 7 days
Germination and Transplanting: 20-25
Transplanting and Harvest: 75
Transplanting Distances:
Between Rows: 30 cm (12')
Between plants: 30 cm (12")
Plants per m^2: 9
pH 6.5-7.5

Cauliflower is a vegetable with low nutritional values and is also difficult to grow. They should be transplanted to reduce the time required for growing in the larger beds. If left in the seedling bed too long the growth will be slowed. They require bright sunlight during the growout period.

To create white cauliflower heads, the heads must be covered with leaves when it is about 3" in diameter. This produces white colored cauliflower.

Pests: Caterpillars, cabbage root fly, flea beetle, slugs and snails.

Diseases: Club root, downey mildew, leaf spot, wipetail and wirestem.

Harvest: Cut heads of cauliflower when they are firm. They should be at least 6" in diameter.

Chard

(Beta vulgaris)

Planting Info:
Can be Transplanted
Seeds per Gram: 53
Space between rows: 8 cm (3")
Space between seeds: 1 cm (1/3")
Depth: 1.5 cm (1/2")
Germination: 12 days
Germination and Transplanting: 12- 18
Transplanting and Harvest: 70
Transplanting Distances:
Between Rows: 20 cm (8')
Between plants: 20 cm (8")
Plants per m^2: 21

Swiss Chard is a green leaf vegetable that is used fresh in salads or boiled and served as a vegetable. Chard can usually withstand being picked of leaves if they are harvested lightly (one leaf at a time). Also, when a plant appears exhausted it can be replanted by dividing into parts and then replanted. Swiss Chard is used as a boiled vegetable, and makes an excellent component to a soup or stew.

It can be a mineral robber in the diet, because it can store calcium in the form of oxalic acid. While this would appear to be a good thing, we all need calcium, the oxalic acid cannot be digested and can rob the body of minerals.

Pests: Aphids, european corn borers, flea beetles, leafminers, slugs, and snails.

Diseases: Blight and downy mildew.

Harvest: The outer leaves are picked at 6-8" tall, leaving the smaller inner leaves to mature. Take off any old leaves to encourage new growth.

Chinese Cabbage

(Brassica chinensis)

Can be Transplanted
Seeds per Gram: 280
Space between rows: 8 cm (3")
Space between seeds: 2 cm (2/3")
Depth: 1 cm (1/3")
Germination: 6 days
Germination and Transplanting: 18-20
Transplanting and Harvest: 60
Transplanting Distances:
Between Rows: 30 cm (12")
Between plants: 30 cm (12")
Plants per m^2: 9
pH 6.0-7.5

Chinese cabbage can be used as a lettuce or cooked like cabbage. It grows faster than traditional cabbage and is a good substitute. It has a bit more food value than lettuce. It can bolt easily in hot weather, and they can also grow very rapidly, harvested a month sooner than cabbage.

If outer leaves seem floppy it will help to form a head to tie the leaves together loosely with raffia.

Harvest: Pull up whole plant when it reaches 18" tall. Younger plants can also be harvested for more tender leaves.

Corn

(Zea mays)

Planting Info:
Directly Seeded
Seeds per Gram: 40
Space between rows: 30 cm (8")
Space between seeds: 30 cm (8")
Depth: 3 cm (1.25 inch)
Germination: 6 days
Germination and Harvest: 90
Plants per m^2: 11

Corn includes several varieties and colors of corn, an ancient and traditional food for many Native American tribes. Indian corn includes a blue corn which has 12% more protein than the more common sweet corn grown in modern gardens.

Corn pollinates the silk coming out of the corn from the tassels at the top of the plant. If each silk is not pollinated there will be missing corn kernals. Ears of corn that are not fully filled out is a result of poor pollination. Planting several short rows is better than one or two long rows. This will ensure proper pollination. In a very small garden you can take a tassel and go around tapping some of the pollen on each of the silks to increase pollination.

Corn can grow very tall in hydroponic culture. At least 50% of the plant is stalk and not usually eaten. Corn syrup is made from the inner part of the stalk, and it can be used to make a sugar. Corn stalks make a good paper product and can be used to wrap food. They are also excellent in composting or in the worm farm.

Corn is an important staple food for many cultures around the world. There are several varieties of corn including flint varieties that are good for grinding into corn flour. A white corn is used in Africa for a daily corn mush.

Corn provides a substantial amount of calories, protein and carbohydrates, so it can be an important part of a diet.

Pests: Blister beetles, chinch bug, corn earworms, cucumber beetles, european corn borers, flea beetles, and Japanese beetles.

Diseases: Bacterial wilt, corn smut, mosaic, and rust.

Harvest: Check an ear of corn by pulling back the shuck at the end of an ear to see if its filled out. Juice from a kernel should spurt out when poked at with a fingernail. Generally, when the silk turns brown and the ear is firm when squeezed it's time to harvest the corn.

Corn growing in a hydroponic tub. The tub will produce about 12 ears of corn every harvest.

Eggplant

(Solanum Melongena)

Planting Info:
Can be Transplanted
Seeds per Gram: 350
Space between rows: 8 cm (3')
Space between seeds: 1 cm (1/3")
Depth: 1 (1/3")
Germination: 10 days
Germination and Transplant: 20-25
Transplanting and Harvest: 75
Transplanting Distances:
Between Rows: 40 cm (16')
Between plants: 40 cm (16")
Plants per m^2: 5
pH: 5.8-6.2
temperature 19-27°C (61-80°F)

Eggplant can be used as a meat substitute. It is a tropical plant and is resistant to cold temperatures.

Eggplants only keep for a week off the vine, and they should be picked when very glossy. To keep the eggplant producing more fruit, pinch off extra flowers for a week, let fruit set, then let flowers grow for second crop and so on. Each week keep the plant to four or five stems, so remove a few leaves or new stems to allow light to reach the fruit below.

Pests: Aphids, colorado potato beetles, cutworms, flea beetles, leafhoppers, potato tuber worms, thrips, aphids, white fly and spider mites.

Diseases: Fruit rot and verticillium wilt.

Harvest: Pick eggplants while they are firm and shiny, just as they start to fade in color. Allowing the fruit to overmature will discourage new growth.

Melon

Planting Info:
Directly Seeded
Seeds per Gram: 50
Space between rows: 30 cm (8")
Space between seeds: 30 cm (8")
Depth: 3 cm (1.25")
Germination: 6 days
Germination and Harvest: 90
Plants per m^2: 11

Watermelon

Space between rows: 40 cm (16')
Space between seeds: 40 cm (16")
Depth: 5 cm (2")
Temperature 55°F-80°F

Melons should be planted to receive lots of sun in a warm place. They are vine crops that require strong support. Larger melons such as watermelon can reach sizes of 22 pounds, and will require strong support. All forming melons should be kept off of media by suspending or by separating with a piece of glass. Melons form flowers that might have to be fertilized by hand.

Pests: Slugs, spotted cucumber beetle, and striped cucumber beetle.

Diseases: Fusarium wilt, mosaic, and powdery mildew.

Harvest: Harvest the fruit when the stem looks cracked and shriveled and the curl has turned brown. If the melon does not come off the vine with a slight turn, the fruit is probably not ripe.

Peas

(Pisum sativum)

Planting Info:
Directly Seeded
Seeds per Gram: 250
Space between rows: 10 cm (4")
Space between seeds: 7 cm (3")
Depth: 3 cm (1.25 inch)
Germination: 5 days
Germination and Harvest: 90
Plants per m^2: 21
pH from 6.0 to 6.5

Snow peas are grown primarily for their pods which are used in many vegetable dishes. Peas can be picked green in the pod and eaten as a vegetable, or allowed to mature and harvested for their pea seeds which can be dried and stored.

When peas are about three weeks old they will need some sort of support to vine up to the top of the support.

Pests: Aphids, cowpea curculio, cucumber beetles, leafminers and stink bugs.

Diseases: Fusarium wilt, mosaic, and root rot.

Harvest: Once pea plants are established, they can continue to produce for a few weeks. The pea plants will stop producing peas if some pods are allowed to fully mature. It seems that if the plant "sees" its reproductive mission accomplished it dies. So it is important to make sure to pick peas before they are matured, or then allow then all to mature and then

Soybeans

(Glycine soja)

Planting Info:
Directly Seeded
Seeds per Gram: 250
Space between rows: 15 cm (6")
Space between seeds: 15 cm (6")
Depth: 3 cm (1.25")
Germination: 5 days
Germination and Harvest: 70
Plants per m^2: 9
pH from 6.0 to 6.5

Soybean plants are annual, and will have to be replanted at least twice a year. There are dwarf soybean plants and tall plants that grow high, similar to climbing vine beans. Common yellow soy bean grows to about 20 inches tall in soil, and may grow to 48" in hydroponic culture.

It has small green or lilac flowers that grow into hairy pods with two too three small beans. The beans are pale yellow when ripe, and will start producing about three months after starting.

Etampes Yellow soy bean - is a plant that grows to about three feet in hydroponic culture, and produces very large soy beans. It is very productive and produces very nutritious vegetables. The pods can also be eaten green.

Once bean plants are established, they can continue to produce beans for over a month. The bean plants will stop producing beans of some pods are allowed to fully mature. Then the plant "sees" its reproductive mission accomplished and dies. So it is important to make sure to pick beans before they are matured, or then allow then all to mature and then pick.

Soybeans can be picked green in the pod and eaten as a vegetable, or allowed to mature and harvested for their bean seeds which can be dried and stored.

Soybeans are a very important part of a hydroponic diet because they supply a full protein with all eight essential amino acids. If one cup of cooked soybeans is eaten, it supplies all essential amino acids. To supply all needed protein requires slightly over two cups of cooked soybean (2/3 cup dry beans). If soybean is mixed with wheat or rice even higher values of protein are realized.

Soybeans are available in many different varieties, varying from those grown for animals to those grown for human consumption. The latter, called edible soybeans, are high in protein and are popular as a meat substitute for vegetarians.

Soybeans are also very high in fat content. This is very good in a hydroponic diet where most fat rich foods, such as peanut and sunflower, are more difficult to grow. The 2/3 cup of dry soybeans also provides 1/2 the daily fat needed.

Soybeans must be cooked to release their food value. Once cooked they can be turned into a soy milk to drink, soy nuts, a soy yoghurt or cheese. As a bean they can be added to stew to make a soup very nutritious.

Pests: Bean leaf beetle, Mexican bean beetle, spider mites.

Harvest: Edible soybeans are harvested when the mature pods are still green. Soybeans grown for animals are often harvested and left to dry or, on a larger scale, left to dry in the field and then harvested.

Squash

Planting Info:
Directly Seeded
Seeds per Gram: 50
Space between rows: 10 cm (5")
Space between seeds: 7 cm (3")
Depth: 4 cm (1.5')
Germination: 7 days
Germination and Harvest: 120
Plants per m^2: 11

There are many types of squashes and most parts of the plant are edible, the seeds, the blossoms and the leaves. All forming squashes should be kept off of media by suspending or by separating with a piece of glass.

Squash blossoms may have to be pollinated by hand. The blossoms can also be eaten and are a good source of vitamins. The squash seeds are a valauble source of fats.

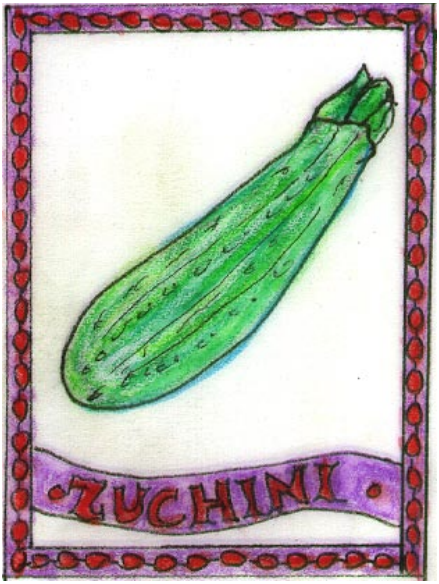
Pests: Cucumber beetles, leafminers, spotted cucumber beetle, squash bugs, and squash vine borers.

Diseases: Downy mildew, fruit rot, mosaic, powdery mildew

Harvest: Squash should receive partial shade as they ripen and they should be picked only after they have changed color and sound ripe. A ripe sound when hit is sort of a hollow sound.

Zucchini

Planting Info:
Directly Seeded
Seeds per Gram: 100
Space between rows: 50 cm (20")
Space between seeds: 40 cm (16")
Depth: 3 cm (1.25")
Germination: 7 days
Germination and Harvest: 90
Plants per m^2: 4



Zucchini squash are ground crops that require lots of space and strong support. All forming squashes should be kept off of media by suspending or by separating with a piece of glass.

Zucchini blossoms must be pollinated for the squash to form.

When the zucchini form, they usually ripen quite fast. They should receive partial shade as they ripen.

Pests: Aphids, red spider mites, slugs and snails.

Diseases: Cucumber mosaic virus, foot rot, grey mould and powdery mildew.

Harvest: Zucchini should be harvested while the fruit is still young and immature. Be sure to keep all overmatured squash picked to encourage plant vigor. A zucchini squash can grow very fast, with a vegetable reaching maturity in a single day.

Plant Nutrient Deficiencies

Plants receiving good ventilation and plenty of water will get all the hydrogen, oxygen and carbon that they need. The remaining necessary 13 minerals are supplied to the plant through a hydroponic nutrient.

A nutrient deficiency will show up in a plant by a change in its leaves or other above ground parts. Most nutrient deficiencies show up in leaves.

The first step in identifying the missing nutrient is examine the plant to see if the deficiency is evident in old or new leaves. Some nutrients are mobile or able to leave old tissues and move to new tissues, so signs of problems show up in older leaves. Other nutrients are immobile and so deficiencies show up in new growth.

Mobile Nutrients - deficiencies first show up in older leaves

Nitrogen - The primary nutrient required by most plants is nitrogen, and it is the most likely missing nutrient. Older plant leaves deficient in nitrogen are a pale yellow or light green color. The deficiency of nitrogen limits chlorophyll and green pigments are reduced in the leaves.

Phosphorus - necessary for normal growth, the first sign of deficiency is stunted growth. In more severe deficiencies, the older leaves become purple or brown. Stems may redden and leaves are often dull and very dark.

Potassium - first signs of deficiency are shortened spaces between leaves, dwarfed plants and a loss of dark green color in the leaves. The older leaves show signs of deficiency first, often showing purplish brown spots, or small white spots. The lower leaves first appear mottled, then scorched. Older leaves start to show dead leaf edges and tips of growing tissues.

Magnesium - required for chlorophyll, and deficiency shows up as a yellow striping in lower leaves. Older leaves become reddish-purple along edges and tips, then white and brown.

Chlorine - plant becomes prone to wilting and leaves die off to a bronze color.

Molybdenum - older leaves die at the tips, and then younger leaves wilt, curl upward or become twisted.

Immobile Nutrients - symptoms first show up in younger leaves

Sulfur - deficiency shows up as a stunting of the plant, a yellowing of leaves with veins remaining green. This shows up first in younger leaves, with purple showing at some bases of leaves.

Calcium - first signs of deficiency are younger leaves that do not unfold properly, look dark and crinkled. Often the leaf ends are stuck together.

Zinc - leaves often show a wide band of bleached tissue. There may be reddish or brown spots on older leaves, and new leaves may be very small. Growth is stunted.

Iron - younger leaves and veins of leaves show a bleaching becoming white.

Manganese - younger leaves show gray-brown or black spots of dying tissue.

Copper - younger leaves become yellow and some areas of dead or dying tissue occurs along the edges. Green color changes to a dull olive or gray.

Boron - delays forming seeds and flowering. Deficiency is first seen on younger leaves as white spots scattered between vein and death on growing tips. Tissues are brittle and sometimes have saw toothed edges.

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Glossary

A

absorption - intake of water and materials by plants.

acidity - sourness or amount of hydrogen ions in solution. Having a pH less than 7.0.

adobe - a construction material made of clay, sand and soil. It is used to build buildings, cooking stoves and garden walls.

adsorption - removal of materials from solution by soils or media.

annual - a plant that only lasts for one season, and reproduces itself the next year from seed.

antibiotic - tending to prevent, inhibit, or destroy life. Used to treat and remove infections.

antiviral - a substance that should prevent, inhibit or destroy viral infections.

anti-inflammatory - a substance to treat inflammation.

aphids - a small fat looking insect that can reproduce by laying live female larvae. They are spread by ants that milk the dew from the aphid.

arsenic- a toxic element, which is metallic, gray, crystalline and brittle. Commonly used as an insecticide or weed killer.

B

bacteria - single celled microbes that decompose dead plant material and attack live plants. Those that attack live plants are called pathogens. Rots decay leaves and stems. Some cause a blockage to occur in plant vascular system causing distress. Galls are excessive growth in infected areas. Many bacteria are carried by insects.

bed grower - a hydroponic grower made of a container used for media or floating bed.

biennial - a plant that requires two growing seasons to produce seed.

blanching - a loss of pigments from the leaves of plants.

boron - a metallic element found in nature only in combination. It is necessary for plant survival and important in blooming.

budding - grafting a bud onto a shoot.

C

calcium - a silver white metallic element occurring only in compounds in the natural environment. It is used in cell wall structure and in bones in animals.

capillary attraction - the surface of a liquid and solids are attracted, an attraction of molecules.

carbohydrate - a chemical compound of carbon, hydrogen and oxygen that is used for energy in plants and animals. Includes sugars, starches and cellulose.

carbon - a non-metallic element found in a pure form in diamond and graphite. Also a chief component in living tissue and in coals and petroleum products.

Centigrade - temperature scale giving freezing water 0 degrees and boiling water 100 degrees. A degree of centigrade equals 1.8 degrees in Fahrenheit. (degrees F = degrees C * 1.8 + 32)

ceramic grow rock - a clay material also called Geolite, which is often used for aquaculture because the porous material is a good media for growing bacteria to clean water. It does not break down.

chlorine - a halogen element which is a heavy greenish yellow gas used as a bleaching agent and a disinfectant of water.

chlorophyll - a green pigment in plant leaves necessary for photosynthesis.

chlorosis - yellowing or loss of green color in a portion or entire leaf. Chlorophyll is lacking or missing.

cob - a form of construction that uses adobe mud and applies layers by hand.

cobalt - a lustrous white metal which occurs with iron and nickel ores. An essential element for root nodules that fix nitrogen for plants, and a part of vitamin B_{12}.

compound - a chemical substance made up of one or more elements.

concentration - the amount of one substance within another, such as the amount of salt in water.

conducting roots - those roots which conduct water and materials through their tissues.

copper - a reddish metal which is ductile and easily conducts heat and electricity. Necessary nutrient for plants and excess is toxic.

D

deciduous - a perennial plant that loses its leaves in the winter season.

density - how many plants or seeds can be planted per unit area.

dermatitis - inflammation of the skin.

determinant - in plants, a type which will produce all its fruits at once and tends to form in a bush shape.

dormancy - a period of rest with low metabolic rates and little or no growth.

downy mildew - a mildew common to plants that looks like a soft downy feather on the plant surface.

drowning - death caused by poor respiration due to water with low or no oxygen.

dry weight - the weight of the plant or material with water removed by frying or heat.

E

ecology - a science of the interrelationships or organisms and their environment.

electric dissociation - some molecules break down into separate ions of positive and negative charge.

element - one of the distinct materials of which all other materials are composed. The periodic table of the elements lists 118 known elements.

embryo flower - the young flower within a bulb, seed or plant.

F

Fahrenheit - the temperature scale where freezing of water is at 32 degrees and boiling of water is at 212 degrees. One degree Fahrenheit is 5/9 degree Centigrade.

fermentation - the chemical and biological processes by which organic materials are broken down by bacteria and other agents.

feeding roots - the new roots which have the capacity to absorb nutrients.

fibrous roots - larger roots that grow from the root crown or large roots.

filtration - water or solution that has passed through a substance that alters its matter in suspension. Solution passing through a porous

article or mass such as soil or media.

fine veins - network of veins near edges of leaves.

fluorine - a nonmetallic halogen that is a toxic gas when isolated.

fungus - fungus are multicellular organisms that include powdery mildew and mushrooms. Most fungus is soil born and not very common in hydroponics. Powdery mildew is air born and spread by white fly. It can be controlled by adequate air movement and ventilation.

forcing a crop - plants are grown by heating the solution, media or air. Plants grow in spite of outside low temperatures.

G

gangrene- pervasive decay or corruption, common in potatoes.

germination - seed sprouting and the first signs of growth.

graft - propagation of a plant by placing a bud or scion in a rooted live plant.

H

hard water - water that contains bicarbonate of calcium or magnesium. It tends to leave a hard white deposit on surfaces where water is frequently used. Hydroponic water is hard water.

herbs - any of a number of green plants used for flavoring foods, teas, or medicinal purposes. Some of the parts of herbs used include flowers, stems and roots as well as leaves.

hybrid - the offspring of two species, often used in plants to develop new breeds of plants.

hydrogen - a gas which makes up about 6% of the earth's atmosphere. Hydrogen and oxygen are the components of water. A necessary component of carbohydrates and proteins.

hydroponics - the science of growing plants without soil. Nutrients are given to the plant through the water.

I

ignition loss - the loss in weight by combustion heating.

indeterminant - in plants, the fruit will appear in stages, or not all at once. Usually a vine crop with successions of blossoms.

indicator - chemical used to determine the pH of a solution of water.

inter-cropping - growing more than one crop together.
inorganic - chemicals not containing carbon molecules as a nucleus. Chemical nutrients in hydroponics.
insoluble - not soluble in water.
internode - space along shoot between two adjacent leaves.
iodine - a non metallic halogen which forms heavy blackish gray crystals. Used as a disinfectant as it kills most bacteria.
ion - a part of a molecule which dissociates and carries a negative or a positive charge.
iron - a heavy magnetic metallic element that readily rusts in moist air. In most igneous rocks and used for nails in carpentry.

L

lateral veins - veins connected to mid-rib vein that run to outer edges of leaf.
liter -a measure of volume containing 1000 cubic centimeters or 1.0567 liquid quarts.
litter - any vegetable matter used as a growing media.

M

manganese - a grayish white brittle element which resembles iron but in not magnetic.
magnesium - a silver white metallic element used in light weight alloys. It forms the central molecule in chlorophyll and is essential to plant growth and survival.
media - the substance used to support plant roots in hydroponic culture. Can be rocks, pebbles, sand, perlite, vermiculite, sawdust, or various types of plant litter.
mid-rib - main vein of leaf extending from tip to stem.
mosaic - a pattern of mottled appearance of plant leaves. Usually caused by a disease spread by insects.
molecular concentration - quantity of dissolved solution expressed in molecules per unit of volume.
molybdenum - a metallic element that resembles chromium and is used to strengthen and harden steel. It is a trace element in plants and animals.
multiple cropping - growing more than one crop in a unit area to make greater use of space.

N

necrosis - tissue which has died.

nematodes - very small soil born worms that live on the roots of plants. They can be introduced to hydroponic culture on the soil of transplanted plants.

nitrogen - a tasteless odorless gas that makes up 78% of the earth's atmosphere by volume. It is an essential part of amino acids or proteins.

no media - There are many hydroponic systems that use no media whatsoever. The plant is usually started in a small piece of rockwool, or specially designed plastic collar. The plant is then placed in a growing tube or container that applies nutrient water to the roots.

nutrient - food, either organic or inorganic used for plant growth.

nutrient solution - a solution containing the necessary elements required for plant growth.

O

organic decomposition - decay or disintegration of plant or animal materials.

osmosis - diffusion of liquids, usually passing through a membrane changing concentrations on either side.

osmotic pressure - measure of force or pressure caused by osmosis.

oxygen - an element that makes up 21% of the earth's atmosphere. Oxygen and hydrogen are the components of water.

P

pea gravel - this media is gravel graded for size and shape. It is not a porous media so it does not wick water from below and must be used in a system that provides aeration for the water. It can be used to grow bacteria as well as plants.

peat - there are three types of peat: peat moss, reed sedge and peat humus. Peat is very acid and can lower the pH of the nutrient water. It breaks down after one or two growing seasons.

perennial - a plant that continues to grow after two years.

perlite - a volcanic rock of gray obsidian that has been heated to 1200^0F in a kiln and expanded. It is a light weight porous material that can "wick" water from a bottom container of water.

permeable membrane - a membrane that allows some materials to pass through.

petiole - part of leaf between blade and shoot where leaf is attached to shoot.

pH - a measurement of the acid or alkalinity of a solution or media. Lower pH (under 7) is more acid and higher pH (above 7) is more basic or alkaline.

physiology - the study of the functions and activities of living matter; organic processes and function of living organisms.

phosphorus - a nonmetallic element that occurs in phosphates. Very important nutrient in hydroponics.

photosynthesis - process where plants convert light energy to organic sugar molecules, building carbohydrates from carbon dioxide and water.

pigmentation - color other than green of chlorophyll.

plant food - the elements in nutrient solution required for plant growth.

pollination - introducing pollen into seed cells, fertilization of the plant reproductive organisms.

potassium - a silver white metallic element that occurs commonly in nature as an ash form left after the burning of vegetable matter. Very important nutrient in hydroponics.

powdery mildew - a mildew that appears as small white spots on plants. Then the spots grow larger and spread. Often caused by poor air movement or circulation.

ppm - parts per million. A measure of the concentration of one substance in another.

protein - chemical compounds in plants that are made up of amino acids. These molecules include nitrogen and some include sulfur.

precipitate - insoluble compounds formed in solution by chemical reactions.

pumice - a silicon material of volcanic origin used for growing media that can break down after repeated use.

R

rammed earth - a form of coinstruction that uses adobe mud and some concrete. The adobe is rammed into forms and then allowed to harden.

respiration - taking in air and giving off carbon dioxide. The process of using sugar for energy and continuing life process.

rockwool - a material made from rock spun into a fiber like material. A phenol based resin is added as a binder. Rockwool tends to increase the pH of the water.
root crown - the junction between stem and the root section.
root stock - the stock which is used for grafting buds or scions.
root-top ratio - the ratio of weight of root section of the plant as compared to the top portion of plant growth.
root zone - the area in which the roots are growing.

S

salad greens - any greens used in a salad including spinach, watercress, lettuces and other leafy green vegetables.
salinity - the amount of inorganic materials in solution of water.
sand - many sands, such as beach sand, have salts already in the media, that can cause problems in hydroponics. However, sand is a useful media that retains water. It has to be sterilized between crops.
sawdust - where there is an extensive timber production, sawdust may be available. The species of tree is important, with softwoods decaying more slowly than hardwoods. Some sawdust is from logs soaked in salt water and is toxic to plants.
selective absorption - differences in the rate of intake of elements by plants.
sets - young rooted plants transplanted into a larger space for full grow out.
scion - a bud or shoot used for grafting onto another plant.
seedling - a small plant, just after germination.
selenium - a non metallic element that might prevent cancers in animals. It occurs in varying amounts in soils, and can be deficient or toxic.
self-pollinating - a plant like tomato that can use the pollen from its own reproductive organs to fertilize its flowers.
shoot - the most recent terminal extension of a twig or branch, current seasonal growth.
silicon - a non-metallic element that is a very common element in the earth's crust. It may be required nutrient for some plants, especially cereals.
sodium - a soft white waxy element that occurs commonly in nature as sodium chloride, the salt most common in the earth's oceans.

soft water - water free from calcium or magnesium bicarbonate.
soil - earth material which supports plants, usually made up of organic and inorganic materials.
soil solution - film of liquid around soil particles.
solute - the substance which has been dissolved in water.
spider mites - a very small spider that attacks leaves. It can be identified by small webs in plant leaves.
staple gun - a hand tool that allows for staples to be used in construction hydroponic growers. It uses a special type of building staple.
suckers - new shoots arising from buds at the base of plants.
sulfur - (also spelled sulphur) - a non-metallic element that occurs as a yellow powder, which forms in nature as sulfites and sulfates. It can be used in its pure form to treat plants for fungus diseases.
synthesis - building up new compounds from simpler ones.

T

tap root - main vertical root of the plant.
terminal - outermost extremity of a branch or shoot along axis.
tillers - shoots from buds at the base of a plant, common in grasses and cereals.
toxic - poisonous.
total solids - weight of materials after all water has been removed.
trace elements - elements available or necessary in small quantities.
transpiration - the breathing out of water vapor and oxygen accomplished by the plant from the stomata in the leaves.
transplanting - the action of taking a plant from one location, removing it and replanting it in another.
trowel - a small hand tool used to dig up and help transplant seedlings. Soil growers often use these to help pull weeds.
tub grower - any hydroponic grower that uses a small container with a drain hole at the bottom.

V

vegetable litter - litter from plants.
vermiculite - a volcanic mica which has been popped in a kiln. It can be compressed and lose its porosity.

vine crops - crops that ordinarily put out vines to grow. This includes plants such as cucumber, pumpkin and beans.

virus - very small diseases which cannot be fought with plant antibodies. Diseased plants must be removed and destroyed. A disease DNA which can be transmitted from plant to plant.

W

water culture - growing plants in water.

weather - climate or environmental conditions pertaining to temperature, rainfall, dryness, and wind condition.

weeds - in soil culture, any plants that are not desired in the crop. Weeds and weeding and the need for herbicides is eliminated in hydroponics.

white fly - a very small (less than 1/8 inch) white fly that lays larvae on the underside of leaves.

worms - in hydroponics, earthworms are used in a worm farm to create worm castings used as a hydroponic nutrient.

worm farm - a home for worms that allows worms to convert vegetable materials to a worm waste used as a hydroponic nutrient.

Z

zinc - a bluish white crystalline element that is often used as a protective coating of iron and steel. It is an essential nutrient in hydroponic culture.

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The day that hunger is eradicated from the earth there will be the greatest spiritual explosion the world has ever known. Humanity cannot imagine the joy that will burst into the world.

Federico Garcia