

GARDENING

by Joshua Smith

Garden Overview

SITE

Flat ground is generally an ideal site for a garden. On sloping land with Southern exposure, South facing terraces will provide good cold air drainage. In the Northern hemisphere, Northern slopes result in lower temperatures and can reduce drought stress in mild winter / hot summer climates such as deserts.

BEDS

In order to maximize sun exposure for garden crops, situate beds so they run North-South. Plant taller plants on the North side and lower plants on the South side to avoid shading the smaller plants. Create edge bio-tones for increased productivity using keyhole, spiral bed or partial keyhole patterns, or just stagger the beds or wiggle them. Linear beds are the least productive, use your imagination. Some vegetables like lettuce and squash will tolerate the shade of taller plants. Lettuce, for example, will be slower to bolt when grown in part shade.

Hot climates with mild winters can use Zuni style sunken pits, particularly in desert climates where pit gardens will provide a longer growing season. In cold climates, use raised beds and retaining walls for thermal mass with beds raised

one to three feet tall. The raised beds can help extend the growing season because cold air lies closest to the ground. In mild climates, sow seeds into prepared beds at ground level because there is a long growing season already. However, raised beds will benefit winter gardening. Garden bed retaining walls made of stone provide thermal mass (a mass that retains heat when hot and releases it when temperatures drop) where summer nights are cool. These will also help reduce evaporation, so water use is more efficient.

The garden beds should allow you to reach the center easily and should be no more than four feet in width, or five feet maximum, depending on your reach. Paths can be planted with a mix of low clover and a grass like red fescue. Be sure that a garden cart and / or lawnmower can navigate the path (three to 3½ feet wide is ideal for most). Mow the planted paths and use the clippings for compost biomass providing carbon and nitrogen. Or cover the path with a weed barrier and either mulch them, or use ¼ inch or smaller sharp, crushed rock (not pea gravel) atop the barrier. Rake the crushed rock out evenly, rent a lawn roller, fill it with water and pack the crushed rock firmly by repeatedly rolling over it. The ¼ inch or less crushed rock packs so smoothly you can walk on it without discomfort. In cold climates, these rock paths act both as heat sinks with micro-climatic effects, and as mulch that traps heat in the soil in the fall. Wherever winters are cold and summer nights are cool, rock paths benefit the garden climate.

BUILDING SOIL AND MAINTAINING GARDEN BEDS

It is often wise to water beds before amending soil and planting to let any weed seeds that are near enough to the surface germinate, then turn them in. It's prudent to repeat this process again before planting to ensure a nearly weed-free start for a good seed establishment and to minimize weed problems later.

Good compost is very important for organic crop production. Compost provides the structure and habitat for a living soil and good tilth (soil structure, particularly

relating to crop growth). Spread compost over your beds at least two to three inches deep, and up to four to six inches if practical. Ideally when first preparing your garden soil, mix your fertilizers and compost together. Use organic cottonseed meal and worm castings for a balanced NPK (nitrogen, phosphorus & potassium) ratio. Mix the compost, cottonseed meal and worm castings together, and till with the compost into the upper six inches of the soil. Or simply till in compost and use Earth Magic. Finally, rake it into a level seedbed, grade and plant it. Plant intensively, spacing crops closer together than the instructions specify. This provides competition with weeds and resists moisture loss by the soil, thus providing higher yields. (Also see Soils for information on Nitrogen and Mineral fixing.)

With compost in general do not use dog or cat poop or litter because of disease. Also do not use meat, bones, fat or dairy (this breaks down slowly and attracts animals). Do use greens, veggies, fruits, grains, dust, hair, nail clippings, the debris of cotton, wool, and silk, shredded paper. Coffee ground or sheet mulch. Lay down old cotton or wool rugs, cardboard. Add mulch of straw, leaves with grass clippings and mix with coarser materials and place thinly or they will make an impenetrable mat.

If you raise chickens or other micro livestock, feed them kitchen waste and compost their manure. Use them in chicken tractors to eat bugs and weeds while fertilizing the garden. If you raise red wigglers (*Eisenia fetida*), feed kitchen scraps to them. Use their casting to enrich the soil.

Compost bins are optimally four feet wide and four feet deep with two to three sections for turning and keeping finished material. **Wood bottom with drainage holes and maggots perish. Cover top with slanting cover for rain. Heats better with solid sides.** Allow one side to open.

The ratio of carbon to nitrogen is important. It varies from ten parts carbon and one part nitrogen, to 100 CO₂ and one part nitrogen. Nitrogen can come from

manure and urine, both work very well. Stable or chicken shed manures most likely already contain urine, and work better than outdoor manures leached by the elements. The high nitrogen content of manures or other compost components, such as the foliage of the Black Locust (*Robinia pseudoacacia*), creates high heat as they break down. Provide part shade for your compost pile.

Pine needles break down slowly.

Volume of finished compost is 40% of original size. **Lay down layers and moisten. Start heating in about three days. Can reach 180°F. Turn piles for aeration, aeration with PVC with holes.** Moisten as needed. To speed up and enrich significantly you can use a biodynamic activator. To start pile, add Yucca extract and or red wigglers after pile has stopped heating.

The faster method's 10:1 ratio made in spring can be done in four to six weeks. Large piles can take a year or more. Time varies depending on systems used and the time of the year the pile is made. Winter piles are basically dormant (unless heated by a greenhouse).

WEED CONTROL

When preparing a site for planting that is weedy, you should mow or weed-eat before the weeds go to seed (the flowers form seed heads). Before cultivating, if the soil is dry, soak it first and wait to till for one to two days. If you have weeds with starchy roots like bindweed or thistles that can propagate from bits of broken roots, then plant smother crops (see below). After the first cultivation, if you do not have weeds of this kind, then water the ground to let weed seeds turned up during cultivation germinate, then till again. Cultivate at least twice to minimize new weeds, and then grade the ground and plant.

SMOTHER CROPS FOR WEED CONTROL

Mexican marigold (*Tagetes erecta*) can grow twelve feet tall. It's especially effective for control of thistle (*Asteraceae* genera) and bindweed (*Convolvulus* species), as well as other weeds with starchy roots. But it doesn't prevent weed seeds from sprouting, or harm other woody plants. Cut down when about five feet tall, leaving some to reseed. The aromatic foliage of the Mexican marigold repels flies, fleas, and lice, and controls fungus and nematodes in the soil.

All the following plants make good cover crops or green manure as well. Winter rye (*Secale cereale*) can double the organic matter in the soil in ten to twelve years, and can produce up to two tons of biomass per acre annually. In field tests, winter ryes have shown they can easily reduce 50% of the weeds by themselves. Plant at the end of summer or in early fall for winter cover. Also good smother crops are alfalfa (*Medicago sativa*), buckwheat (*Fagopyrum esculentum*) and millet (*Poaceae* family).

Grow cover crops after annual crops are harvested and over winter on bare ground. In other words, fallow soil (left untilled or unsown after harvesting) shouldn't be bare soil. Once you have prepared a rich, healthy soil and then plant intensively. Space crops closer together than the instructions specify. This competes with weeds and resists moisture loss by the soil, plus providing higher yields per square foot of garden. The goal with intensive planting is to create a closed canopy planting with a minimum of empty spaces. Thinning seedlings will still be needed to provide adequate room for plant growth, but the tops of each plant when reaching maturity should overlap with their neighbors.

COVER CROPS

Cover crops have several fundamental functions for the landscape and soil. They are used for site preparation in the orchard, windbreak and in fallow garden beds that are not in production. Cover crops are invaluable for smothering weeds, to produce organic matter (carbon) for improved tilth, and to add various available

nutrients for consumption by crops and windbreak plantings. Think of it thus: smother crops for weeds, green manures (cover crops grown primarily to add nutrients and organic matter to the soil by plowing them in and incorporation into the soil) for tilth and rich soil. As a smother crop to control weeds, it is best to plant them a bit denser than the recommended seedling rates.

Cover crops supply the biomass for soil humus (partially decomposed plant and animal matter which forms the organic portion between the mineral soil and the newly deposited layer of organic material). They can be used on temporarily fallow ground, to hold soil in place against erosion, to add organic matter and decompose fast. Cover crops add nutrients to the soil and promote beneficial microbial communities. They can also suppress weeds, which are then called smother crops. They are also sometimes grown as companion crops to minimize weeds, erosion and evaporation.

WINTER COVER CROPS

All of the winter cover crops should simply be mowed or cut back and left to grow, when preparing a site in advance to plant an orchard or windbreak. One exception is kale, which can be replanted in spring if desired. By mowing rather than incorporating the cover crops into the soil, erosion is reduced, water is used more efficiently and according to a USDA study, (alfalfa) provides nearly an equal volume of nitrogen whether it's turned in, cut or even left alone!

Winter Rye: An excellent soil builder with an extensive root system that loosens dense soils for air and water infiltration. Produces about two tons of biomass per acre annually, twice that of wheat or barley. Allelopathic (toxic) to weed seeds, it can reduce populations by 50% without any other weed controls. When it's cut or tilled, it releases its toxic compounds into the soil. A following crop or cover crop should probably not be seeded for at least two weeks or more after the winter rye is turned in, although some crops aren't affected at all. Because rye is high in carbon and low in nitrogen, nitrogen speeds up it's decomposition and perhaps

interferes somewhat with rye's allelopathic influence. Always interplant with a nitrogen fixing legume.

Winter rye is good ladybug habitat. It provides fall growth and spring growth, and is extremely hardy. Gives significant winter protection for kale when interplanted with it. It can inhibit some soil diseases like pink root on onions and black root on strawberries. Used as a control for cabbage moth worms by drying and powdering the rye's foliage. The rye powder is then dusted over whole plants early in the morning, causing fatal dehydration to the worms on contact. Annual rye is also an excellent cover in asparagus beds for worm control.

Culture:

Plant seed in late September to early October. 90 to 100 pounds of seed per acre, or 1½ to two bushels (twelve to sixteen gallons). Cover seed ½ inch deep. Grows rapidly and is easy to grow in almost any soil.

Winter rye is best cut with a sickle bar to avoid matting if used as a permanent "no till" cover for bean crops. If it is to be incorporated into the soil, then a flail mower cuts it finer, so decomposition is advanced. A Buffalo no-till cultivator will not clog when turning rye in; or it can be disked in or turned in with a spring tooth drag (a tractor attachment). Perhaps the best tool is a chisel plow. In any event, some farmers prefer to lightly incorporate it, although some rye will survive even the cleanest cultivation. It can just be mowed. Commonly turned in in early June, some wait until the early pollination stage when it's about four feet tall.

Alfalfa: Can be used as a winter or year round cover crop for site preparation, it is also recommended as a component of the orchard's permanent ground covers. An annual alfalfa variety like "nitro" can be used as a cover crop / green manure for fallow beds.

The champion of nitrogen fixing cover crops, inoculated alfalfa can supply 200 to 250 pounds of nitrogen per acre. Its deep and extensive root systems are adept

at liberating an array of minerals and lifting them into upper soil horizons. It also provides the soil with a plant growth promoting compound, a fatty acid called triacontal.

Alfalfa can produce tons of biomass per acre and attracts numerous species of beneficial insects. Root exudates inhibit wire worms, although this process can take years. Allelopathic to seed germination of corn, oats, peas, soybeans and weeds, alfalfa is an excellent cover smother crop for weed control. Also provides excellent erosion control.

Alfalfa is a highly nutritious food for people, animals and bees (produces a superior honey). Rich in vitamins, minerals and trace elements, it's a first class preventative and very medicinal. It is also rich in antioxidants and co-factors, the first line of defense against cancer, heart disease and strokes. Alfalfa supplies numerous benefits for healthy blood and is effective against many blood related conditions. Alfalfa also offers a great number of other health benefits, too many to list here!

Culture: Plant in late summer, inoculate seed with nitrogen fixing bacteria. Twelve to twenty five pounds per acre, sow ½ inch deep. Select cultivars that are dormant, they are the most winter hardy, and choose those which are best adapted to the site. Tends to take three to five years to reach greatest biomass production. Can be turned in lightly, some will always survive. Or just mow it and let it grow. Can be dry farmed (growing crops without any irrigation) because of good drought resistance. Good with rye because rye gets the bulk of available water.

Scotch kale (*Brassica oleracea*): Can be interplanted with rye for winter cover, and is very easy to grow. Provides edible greens in fall and often again in spring if it survives the winter. It's very cold hardy and with winter rye, it's survival rate increases. Kale is extremely high in beta-carotene and is a good source of B

vitamins and vitamin C. Is good eaten by both people and animals. Some like it better after a frost.

Culture: Plant seed in summer for winter cover, about six weeks before the first frost, or any time between spring and summer for cover cropping. Seed at fourteen to fifteen pounds per acre, plant seed $\frac{1}{2}$ inch deep, pure stands are planted one foot apart. Turn in the spring.

OTHER LEGUMES FOR WINTER COVERS

Hairy vetch (*Vicia villosa*): Easily grown and suitable as a winter cover or a cover for the growing season. Very hardy. Probably second only to alfalfa in nitrogen fixing. September planted hairy vetch can be cut to near ground level in late May or early June. Tomato starts can be planted right into the vetch without cultivating the soil. This method reduces fruit cracking and splitting, gives a more uniform soil temperature, improves moisture availability and provides slow release nitrogen. Can yield about $7\frac{1}{2}$ tons of fruit per acre more than other cultural methods, producing tomatoes of superior quality.

Culture: Plant mid to late August with inoculated seed with 40 to 60 pounds per acre, $\frac{3}{4}$ inch deep. Turns in easily in spring, or decomposes in about a week if mowed.

Austrian winter peas (*Pisum sativum*): Easily grown and very hardy, even more so than hairy vetch. Yields edible peas very early in the year.

Culture: Plant mid to late August with inoculated seed. Sow about 100 pounds per acre, $1\frac{1}{2}$ inch deep in the soil. Easily incorporated into the soil in spring, it also breaks down in about a week if mowed.

SUMMER COVER CROPS

Summer cover crops can be added in cultivation strips alternating with the rye / alfalfa cover, alone or mixed in fallow beds. Summer covers are annual in nature

and will not survive after the first growing season. They may however reseed themselves and most often do. It is recommended that they be kept cut when they flower to control reseeding and more importantly to incorporate more nutrients into the soil. Plants invest a tremendous amount of their own nutrition into their seed, so their organic matter is greatly depleted of minerals and trace minerals. Beyond carbon, they give little to the soil improvement once they start producing seed.

Buckwheat: Rapid germination and growth gives it a jump on many weeds, making it a good smother crop. A good biomass producer, and fairly drought tolerant. Can be tilled in when it first starts to flower and replanted for a second biomass crop. Or it could be mowed or cut back occasionally and left to grow through the season until killed by frost. It should be cut back at flowering time to maximize its soil benefits, with maximum benefits reached when about $\frac{1}{4}$ of the crop is in full flower. Otherwise precious nutrients will be utilized by the plant to flower. Let it flower and go to seed only if you plan to collect the seed for future plantings. Some will reseed anyway.

Culture: Plant after danger of frost has passed at about 50 to 70 pounds per acre.

Millet: Fast growing and drought tolerant, millets are good smother crops for weed control and biomass production. Millet is high in carbon but low in nitrogen, so interplant with legumes. Among the most nutritious grains, having all the essential amino acids except lysine, which is found in legumes and meat.

Culture: Plant early to mid June, about eight pounds per acre, $\frac{1}{4}$ inch deep. Can be mowed or rolled, but take it down before it sets seed. Some are likely to reseed in any case.

ORGANIC FERTILIZERS

Price comparisons are based on the rate of application, not price per pound. This is the number of pounds used per square foot rather than the prices per pound, as with some products, a little bit goes a long way and are worth the apparently higher cost.

NITROGEN SOURCES (N)

Feather Meal: 11 to 14% nitrogen, one of the richest sources of N, as well as the cheapest. A slow release fertilizer applied at the rate of 25 to 50 pounds per square foot.

Seabird Guano: NPK is 12-8-2. Although a little over three times more expensive (usually) than feather meal, seabird guano is a complete fertilizer providing phosphorous and potassium as well as nitrogen. A fast release fertilizer, it can burn plants if over applied. Application rate of 50 pounds per 1000 square feet.

Blood Meal: 14% nitrogen plus trace minerals. A bi-product of meat production, vegetarians often cringe at the idea of using blood meal, but using it in no way supports the meat industry, to whom it is just waste. A mid-release fertilizer, use it to bind the soil and feed beneficial soil microbes. It costs about as much as seabird guano, or about half as much for the lowest application. 50 to 100 pounds per 1000 square feet.

Bat Guano: NPK is 10-2-1. A complete, fast release fertilizer, though less complete than seabird guano and also more expensive. 50 pounds per 1000 square feet.

Cottonseed Meal: NPK 6-2½-1. Another moderately complete, though slow release fertilizer. A heavily sprayed crop, so only use organic cottonseed meal, although it's often hard to find. 100 pounds per 1000 square feet.

Soybean Meal: NPK 7-2-1. A complete fertilizer similar to cottonseed meal. Virtually all US grown conventional soybeans are genetically modified, and it's estimated that nearly half the organically grown soybeans have been contaminated by GMOs. Soybean meal is generally expensive, only bat guano is more so. Not recommended as a fertilizer. Application rate of 80 pounds per 1000 square feet.

PHOSPHOROUS SOURCES (P)

Colloidal or soft rock phosphate: The best source of phosphorous, which is essential for transporting energy throughout plants. Without it, plants do poorly and lack good nutrition, yet it is much depleted in US soils. Other forms of rock phosphate, those most often sold by nurseries and farm supply houses, are very toxic and their mining is highly polluting. Only colloidal or soft rock phosphates are non-toxic to plants and animals, including people. In addition to phosphorous, it is also a source of calcium, essential for good plant growth and also fourteen trace minerals. Both a fast and slow release fertilizer. Apply at 50 pounds per 1000 square feet on deficient soils, less on fertile soil.

Steamed bone meal: NPK 2-11-0 and 22% calcium. More expensive than colloidal soft rock phosphate and can be extremely slow release. Ground extra fine, the release can be somewhat faster. Apply 50 pounds per 1000 square feet.

SOURCE OF POTASSIUM (K)

Kelp Meal: Absolutely the best source of K, plus over 70 trace minerals, vitamins, enzymes, hormones and plant growth regulators. Excellent food source for essential microbial communities. Excellent broad spectrum fertilizer, quickly

available source of nutrients at a very reasonable price. Apply ten pounds per 1000 square feet.

COMPLETE FERTILIZER SOURCE

Worm Castings: NPK can be quite variable, but it's typically a very rich source of nitrogen, phosphorous and potassium, with a good balance of exchangeable calcium and magnesium. Imbalances are not unusual in native soils, but can be a problem for crops. Also a source of trace elements, enzymes, growth hormones and beneficial soil microbes. They are a great way to establish and increase soil microbe populations. They are quite expensive and quality can vary considerably from one product to another. Look for worm castings that contain a minimum of soil and no undigested organic material. Because of cost, rely mostly on less expensive organic fertilizers, mixed with a modest amount of worm castings. Castings may also inhibit or suppress plant pathogens. Apply ten to 20 cubic feet per 1000 square feet.

MULTI-VALUE SOIL PRODUCTS

Yucca extract: Delivers stress resistance to crops in the orchard, vineyard or veggie patch. For example, during droughts crops that have been treated with yucca provide near normal yields, while untreated crop yields are diminished or even fail. Yucca extract is also the perfect food for beneficial microbe communities which explode in growth when fed with yucca. As a surfactant, or wetting agent, the extract reduces surface tension when added to irrigation water, so that water is quickly absorbed into the soil. This is particularly helpful with heavy, tight soils, and where surface evaporation or runoff is high. Yucca is often used as a sticker-spreader for foliar feeding. It helps liquid fertilizers to cling to foliage until they're absorbed, plus adding its own beneficial substances to the plants as well. Because yucca contains a wealth of saponins (natural substances that form soapy froth in water), it's ideal for flushing out debris that clog drip system emitters.

If possible, plant plenty of yucca for these and the following reasons. Yucca's newly emerged and tender flower stalks are delicious steamed. Or let them bud out and swell, then harvest the sugar rich flower buds and steam them for a delightful meal. If you miss these two opportunities, then you can harvest the sweet, delicately textured flower petals (remove the tough part as it is bitter). Even the fruits are edible, the broad leaf yucca fruits are large and have a tasty pulp, but they are very seedy. The seeds are licorice flavored and edible plus they're uniquely attractive, excellent for bead work and crafts. The narrow leaf yucca fruits are smaller and bitter, but cooked in a few changes of water while still immature, they resemble squash in flavor.

Yucca has been grown commercially for the shampoo industry. In particular, its saponin rich roots have a long history as a natural soap. It also has significant medicinal properties. The leaves provided the native peoples of the Southwest and Mexico with a high quality fiber that they made dozens of products from for hundreds of years. In WWI and WWII, the US government used yucca fiber for twine, rope, burlap and heavy paper. Even today its fiber is used to make heavy craft paper for weather stripping and flashing. Finally, yucca extract can play a significant role in ecovillage waste treatment. Populations of decay organisms increase rapidly when yucca is added to the waste stream, and they quickly devour organic waste, accelerating the decomposition process. Yucca is so effective that it is widely used in municipal waste treatment facilities for this purpose.

Earth Magic: A living soil amendment designed to establish healthy populations of soil microbes, and mycorrhizal and decay fungi. These are critical organisms for a healthy, dynamic soil ecosystem. Earth magic is proven to increase plant growth, shorten the germination time of seeds, reduce transplant shock, promote increased flowering and give higher fruit yields. The University of Florida's Inoculum Research Laboratories tested it against all the living soil amendments on the market, and Earth Magic received the highest rating, performing well above EM (not to be confused with Earth Magic, it stands for "Effective

Microbes”). Earth Magic is the first product to do so, as EM performed significantly higher than all the other living amendments.

A 50 pound bucket of Earth Magic contains the humic equivalent of 8000 pounds of premium compost one year after incorporation in the soil. Earth Magic is inoculated with up to ten billion viable organisms per gram of cultured humus. It contains bacterially and fungally inoculated compost (including both endo- and ecto- mycorrhizal spores), freeze dried fish protein (the one pound of protein crumbles that is part of the Earth Magic protocol is the equivalent of 50 gallons of fish emulsion), kelp, worm castings, yucca extract, rock dust and digestive enzymes.

For information on cover crops and plants that harbor pest controlling beneficial insects, see Eco-Orcharding.

Earth Magic can be obtained by contacting Soil Secrets, LLC, in Los Lunas, NM. Michael Malendres is the maker, and Elliot Hoss his Santa Fe distributor at 505 770 8584, or email soilsecrets@aol.com. Please mention you heard of Earth Magic from me.

GENERAL GARDENING TIPS

Yucca extract is used on many commercial truck farms and orchards in the Southwest as an anti-stress factor, of particular value against drought stress in crops. Many a commercial crop has been saved by yucca extract during harsh climactic periods. Yuccas themselves are easy to grow, extremely drought tolerant and require a minimal allotment of marginal land. In addition, yuccas are edible, medicinal and due to the surfactant (a wetting agent that lowers the surface tension of a liquid, allowing easier spreading) qualities, are used in foliar feeding of plants to increase the absorption of liquid fertilizers. In low pressure irrigation systems like a drip system, yucca's saponins keep emitters from clogging. Yucca extract is also the ideal beneficial microbe food, so much so it is used to accelerate waste decomposition in many municipal waste treatment

plants. This makes yucca a dynamic biological addition to composts, thereby increasing compost's value for soil improvement. Because yucca is a rich source of saponins, plantations are grown to supply the shampoo industry. Finally, yucca fiber has been used extensively for thousands of years for everything from burlap to paint brushes, and from paper to rope. For more on yucca, contact Joshua Smith to obtain his booklet "Botanical Treasures of the West" on CD.

Cold Climate Strategies

COLD FRAMES

Cold frames (a transparent-roofed enclosure built low to the ground) may be used to extend the growing season. Perforated solar heat pipes buried in beds covered by cold frames extend the season even further. Cool season crops such as kale and chard can be grown outside all winter in temperate climates, and in very cold climates they can survive the winter in cold frames.

Produce Varieties for Cold Climates

* = High Altitude Gardens, Seeds Trust, PO Box 596, Cornville, AZ 86325

Phone: 928 649 3315 Fax: 928 649 8181 Web: www.seedstrust.com

= Seeds of Change Phone: 888 762 7333 or 762 4240

Web: www.seedsofchange.com

^ = Seed Savers Exchange, 3094 North Winn Road, Decorah, IA 52101

Phone: 563 382 5990 Fax: 563 382 5872 Web: www.seedsavers.org

Bush Beans, "Venture"- Bred to perform in cold soils. Plant one variety only to avoid cross pollination. This variety matures fast (48 days). Good fresh, frozen or canned. *

Beets, "Early Wonder"- Good salad greens and very sweet beet roots, fastest and earliest beet variety to mature (48 days). *

Brassicas: broccoli, brussel sprouts, cabbage, cauliflower and kale are all closely related brassicas. Because of this and also since they are all insect pollinated, if they are grown within 1000 yards of one another and bloom together, they will cross pollinate and pollute the seed strain. If you grow any combination of brassicas, either make sure they bloom at separate times without overlap, or buy seeds each year, or sacrifice the blossoms of all but one of the brassica crops by cutting them back.

Brussel sprouts, "Long Island Improved"- Tender and succulent, productive. Best flavor after a few frosts, can be harvested in the snow during fall or winter, good for freezing. 110 days to mature. * #

Broccoli, "De Cicco"- Very dependably prolific, open pollinated. Sweet and tender heads produced over very long period. After final harvest, side shoots develop numerous small heads in fall. Mature heads hardy to about 10°F, young plants aren't tolerant of frost. 65 days to mature. #

Broccoli, "Nutri Bud"- Extra rich in available glutamine, a potent nutrient and healer. Fast growing (55 to 70 days), a cool weather crop, plant in spring or summer for fall harvest. Mature plants hardy to near 10°F. #

Cabbage, "Primax"- Very sweet, open pollinated, heads weigh up to three pounds. Although very young plants are not frost tolerant, mature heads are hardy to 10°F. Cabbage heads with roots (broccoli too) can be taken in for winter, then planted in early spring with the heads' base at soil level. 63 days to mature.

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Cantaloupe, "Minnesota Midget"- Four inch diameter fruit, thin rind, mostly meaty flesh of excellent quality and super sweet. Small vines seldom more than three

feet long. Grow on the south edge of beds and let them train down a retaining wall for heat. Wilt resistant, matures in 60 to 75 days. ^

Carrots, "Scarlet Nantes"- Very sweet, make great juice, six to seven inches long, thick root, crisp and tasty. Seeds of Change research found this variety richest in amino acids. Excellent fresh, stores and freezes well, super good for gourmet baby carrots. Store some of the best roots and replant in spring, spaced two feet apart. 65 to 70 days to mature. Carrot varieties cross pollinate and produce hybrids of varying character. If growing more than one variety, don't allow them to flower at the same time. * # ^

Chard, "Broadstream Green"- Large wide leaves, green with white stems and veins, succulent. Rich in vitamins and minerals. Takes summer heat and fall cold. Easy to grow, hardy biennial. Heavily mulched it might winter over. Continuous harvest through season. Matures in 50 to 60 days. #

Chicory (frisee), "Salad King"- Lively, piquant, but mild flavor and delicate texture, used as or with lettuce in salads. Hardier and more bolt resistant than lettuce, tolerant of fall frosts. Matures in 45 days. *

Chicory (radicchio), "Augusto"- Tasty peppery flavor. Non-forcing type, only plant seed outdoors and only mid-summer for fall harvest. Do not start out of season or in a greenhouse. Very frost resistant, matures in 70 days. *

Chinese cabbage, "Market Pride"- mature heads weigh about four pounds. Sown in July for late fall harvest, excellent quality. Matures in 65 to 75 days. #

Corn Salad, "Verte de Cambrai"- Softest and mildest of the salad greens, delicate, sweet- nutty flavor. Plant mid to late summer for fall harvest, can winter over and provide early spring greens, very cold hardy annual. *

Cucumber, "Dekah"- Productive, pickle sized. Does very well in northern climates and tolerates weather extremes. Fairly compact vines four to six feet in length, fruit five to seven inches. Two or more varieties will cross pollinate if flowering overlaps, hybrids result. Matures in 42 days. Good pickled, easy to grow. ^

Edible Chrysanthemum, "Shingiku"- Tasty, aromatic greens steamed, stir fried or for a delightful tea. The flowers are fragrant and attractive, in Asia they are used in soups, pickled, dried, fried in tempura better or boiled and seasoned with vinegar and soy sauce. Sow seed in early spring and get succulent greens in two to three weeks. *

Garlic, "Georgian Crystal"- Very large cloves with a rich, aromatic and mild flavor. Easy to peel, stores about six months, maybe more. Plant about 1½ months before soil freezes and mulch heavily. At harvest, stick babies back in the ground for future harvest. #

Kale, "Red Russian"- Very mild, sweet and tender. Young leaves excellent in salads, mature leaves in stir fry or steamed. Hardy to ten below zero, easily winters over. Very nutritious, matures in 50 to 60 days. # ^

Leek, "Blue Solaize"- Good flavor, very hardy, a good winter harvest, even if ground is frozen. Matures 100 to 120 days from starts. ^

Leek, "King Richard"- Sweet delicate flavor, very productive and fast growing. Good frost tolerance to 20°F. Matures in 75 days from starts. *

Leek, "Scotland"- Excellent flavor and texture. Very hardy, probably can overwinter this one. Matures 85 to 90 days from starts. #

Lettuce varieties. Because lettuce are self-fertile, cross pollination seldom occurs. Generally, seeds come true even when different varieties' flowering overlaps. Most of these varieties are hardy to around 20°F, some much lower. Lettuce varieties generally bolt and go to seed at the onset of summer as they're

cool season crops, these varieties are exceptions and some are extra hardy to cold also.

"Big Boston"- Very large to twelve inch diameter. Soft, tender, buttery, delicate flavored leaves with brittle, tender and buttery hearts. Very cold tolerant and also heat tolerant, slow to bolt. Vigorous grower, handles well without damage, good for greenhouse starts, very easy to grow and harvest. Matures in 55 to 70 days. *

"Ithaca"- Very sweet and delicious, large, smooth, crisp leaves. High yields and reliably so. resistant to heat, slow to bolt and free of tip burn and brown rib. Matures in 70 to 75 days. *

"Lobjoits"- Exceptional flavor and very tender texture. Large leaves (to twelve inches long) and hearts. Cold tolerant for fall harvests, but also heat and drought tolerant, very slow to bolt. Matures in 60 to 65 days. *

"Merveille des quatre"- Crispy outer leaves, tender hearts, stays firm even in very hot weather. Very cold tolerant and can be started from seed almost any time of year. Matures in 50 to 65 days. *

"Red Perella"- Dwarf and compact with a delicate buttery flavor. Cut and come again harvest or take whole head and serve as is. One of the hardiest lettuce varieties, having survived 4°F. Sow spring and/or fall. Matures in 60 days. *

Multiplier 'Potato' Onions. Multiplier onions are hardy perennials that produce numerous bulbs for each bulb that is planted. The largest bulbs are harvested to eat, while small bulbs are lifted and stored for planting the following year. It is worth experimenting by putting the smaller bulbs back in the ground at harvest to see if they will winter over outdoors. Bulbs that are small, about ¾ inch, will yield one or two larger bulbs each, while larger bulbs three to four inches will produce

several smaller bulbs each. Grown indoors in winter, they can produce fresh small green onions.

“Yellow Potato Onion”- A mild but richly flavored onion that is three to four inches in diameter when mature. Each bulb can produce up to fifteen onions just below the soil surface. Stores very well for eight to twelve months. Drought tolerant and resistant to pink root. Available from Territorial Seed Co. 800 626 0866 and Ronningers 877 204 8704.

Radish (daikon), "Miyashige"- Extra large roots get twelve to seventeen inches long and two to 2½ inches thick. Mild tasting radish but with a delightful pungent flavor. Excellent for pickling or steam and then stir-fry, or try baking them. Seed in place in late August to early September, and lift most of them after the seed pods turn brown (save the seed). Eat and pickle to your heart's delight, but save some in cold storage for spring planting. Because daikons are biennial, they will continue to grow the second year and get larger. May not produce seed until their second year. Can be harvested right up to the time the ground freezes, and in general they keep well. Mature in 50 to 75 days. *

Radish, "Parat Sperling"- This giant can be harvested small or baseball size without splitting or becoming woody, spongy or losing its mild, crisp, pungent flavor. Matures 25 to 35 days. #

Rumex Acetosa, "French Sorrel"- A perennial (one time or permanent planting). Tasty greens with an acidy lemon flavor. Cut and come again throughout the growing season if flower stalks are cut down when they appear. First tender greens of early spring. Easy to grow, matures in 60 days. *

Peas. Peas are self-fertile and pollination is largely over before the flower opens, so insects seldom act as pollinators. For this reason, there is little chance that cross fertilization will occur between varieties.

"Dwarf Gray Sugar"- Pods are sweet, tender and stringless. When the season for tender pods is over, seeds are used for peas. Young shoots and leaves are also eaten. Two to 2½ foot vines do not require staking. Heat and cold tolerant. Resistant to wilt. Matures in 60 to 65 days. ^

"Green Arrow"- Pea type, eight to eleven small sweet peas per pod. Extremely heavy production, easy to pick. About two feet tall, no trellis needed. Resistant to downy mildew and wilt. Matures 62 to 70 days. ^

"Oregon Sugar Pod II"- Edible pods are very sweet, mild and tender. Highly productive and delicious. Vigorous two to 2½ foot vines, do not need a trellis (non-climbing). Very resistant to viruses, wilt and powdery mildew. Matures in 68 days. * #

"Wando"- Pea type, seven to nine medium size peas per pod. Highly productive, two to 2½ foot vines. Quite cold tolerant and will pollinate even in cool conditions. Also performs well in hot weather. Can be planted in late summer for early fall harvest. Matures 64 to 70 days. *

Peppers will cross pollinate unless hand pollinated. If two or more varieties are grown together, hand pollinate them. Grow some outdoors and some indoors in greenhouses. In each case start them well apart in time to avoid flowering overlap.

Hot varieties:

"Espanola improved" - Excellent fresh, roasted or dried. Medium hot in cool short season climates, very hot in warm summer greenhouses. Can be eaten green for mild heat. Ripens red. A native of the Southwest, it produces high yields in 70 to 80 days from starts. #

"Grandpa's Home Pepper" - Medium hot, bright red, high yields. Small twelve inches tall, compact plant from Siberia. Excellent for growing indoors all winter, good yields even in low light, 70 days from starts. *

"Hungarian Hot Wax" - Very pungent, ripens red, excellent canned or pickled. Plants are about two feet tall. Fruit is typically a bit smaller than "Espanola improved" but bigger than "Grandpa's". Very well adapted to cool, short seasons. High yields 58 to 70 days from starts. *

Sweet varieties:

" Sweet chocolate" - Sweet and well flavored chocolate colored pepper with brick red interior. High yields of medium small fruits 60 to 65 days from starts. Very tolerant of cool night time temperatures. *

"Staddons select" - Sweet, crisp and delicious, ripen red, large four inch by four inch fruit with variable shapes. High yields 64 to 70 days from starts. Very tolerant of cool, mountain summer nights, resistant to tobacco mosaic virus. Plant is tall and bushy. *

"Italian sweet relleno" - Sweet, mild and very flavorful, excellent for chile rellenos, or roasted or sauteed. Fairly large red fruits, give high yields 65 to 75 days from starts. Let them fully ripen. #

Potato, "Yukon Gold"- delightfully fine flavor and texture. Reliably productive. Yukon Gold is the largest yellow fleshed variety and the only one that's a good keeper. Excellent for storage. Tubers are round and 3½ to four inches in diameter. Plant two to four weeks before last expected spring frost. Yields in 65 to 95 days. #

Quinoa, "Dave" - Good nutty flavor, fluffy texture, medium sized seeds. Very rich in nutrients and provides high yields in 90 to 100 days. Does well at high

altitudes, a very short season variety. Plant is five to six feet tall and should be planted on the north side of veggies to prevent shading out. Plant seed before night temperatures reach 60°F. #

Radish, "Rat Tail" (*Raphanus sativus caudatus*) - This radish yields edible seed pods rather than roots. Pods have a fairly pungent flavor, like a mild radish, and are about six to twelve inches long. Pick while still young for best flavor and tenderness. Pods are eaten fresh in salads, stir fried, steamed, boiled or pickled. Quite productive, extremely easy to grow and could be grown in open parts of terraces or garden beds. Yield in 90 days.

var. "Madras" - A mild flavored, stringless variety two to three inches long that remains crisp and tender up to two weeks. Excellent raw, steamed or pickled. Attractive pale purple flowers with purple tips, Madras grows two to five feet tall. Bountiful Gardens has carried it in the past, 707 459 6410. ^

Spinach, "Winter Bloomsdale" - Rich, sweet flavor. Good production into early summer. Very cold tolerant, planted late in the season it may winter over. A non-bolting variety and resistant to cucumber mosaic virus and blue mold. Yields in 45 days. #

Squash, summer & winter. Pollinated by insects, so they won't come true to seed if two or more varieties are grown anywhere near each other, unless they are hand pollinated. Plant the squash on the edge of terraces so they can spill down the berm.

Summer varieties:

"Golden scallopini" - Excellent flavor, particularly when picked small. Saucer shaped fruit is three to six inches wide, quite productive and yields continuously if picked regularly. It can also be stored like a winter squash! A bush type, it doesn't ramble like other squashes. A very practical choice if bed space is limited. Yields in 55 to 65 days.#

"Yellow crookneck" - Tasty, buttery flavor, yellow fruit five to nine inches long, very productive right up to the first killer frost. Even immature fruit is delicious. Freeze to store. Another bush type good for limited space, very easy to grow. Yields in 50 to 58 days. # *

Winter varieties:

"Gold nugget" - Sweet and tasty, a fiber free textured fruit of good quality, though small. Weighing about 1½ to two pounds, quick to mature and extremely productive, good keeping qualities. Plant is compact with short vines, a space saver. Fruits resemble miniature pumpkins in form and color. Yields in 85 days. # *

"Royal Acorn" - A tasty, sweet fruit with very tender flesh. Productive, weighing three to four pounds. Delicious baked. A large spreading vine to twelve feet or more. Quick to mature in 85 to 95 days. #

"Ebony Acorn" - Sweet, tasty, tender and juicy fruit weigh two to three pounds and are highly productive. Store very well even in conditions less than perfectly dry. Do not require sun to cure. A vigorous vine. Yields in 90 to 100 days. *

Tomatoes. Because tomatoes are self fertile, two or more varieties can be grown without compromising seed purity. Some insect pollination will occur however, so plant varieties well apart from each other. Many varieties need some support; I've made box trellises with four to six stakes. Twine is used for horizontal support and tied to stakes at notches made to prevent the twine from slipping. Although many of the following varieties are among the most tolerant of mountain growing seasons, many will like growing in a summer greenhouse or cold frame, while some will do well in a winter greenhouse. In other words, you can grow a lot of tomatoes all year. A few of the most cold tolerant varieties may tolerate temperatures as low as 18°F, but not over an extended period of time. Some varieties have been selected specifically for their extra rich nutrient content. This

is increasingly important because of global warming. As carbon dioxide increases in the atmosphere, plants' nutritional content declines.

Nutrient rich varieties:

“Peacevine cherry tomato” - Delicious small red $\frac{3}{4}$ inch tomatoes with a complex flavor, somewhat tart with sweet aftertaste. Super rich in vitamin C and high in gamma-amino butyric acid, a relaxant for the nervous system. Prolific yields throughout the season, from 70 to 80 days from starts. #

“Sweetie” - Super sweet and flavorful small red one to $1\frac{1}{2}$ inch tomatoes. In addition to a rich sugar content (about 14%), “Sweetie” is also extra high in vitamin C. A vigorous vine that should be trellised. Very adaptable to various climates, yields in 65 days from starts. In the past, available from Nichols 800 422 3985 and also Territorial Seed Co. 800 626 0866.

“Sweet 100” - Super sweet and flavorful small one inch red tomatoes. Extra rich in vitamin C. Very similar to “Sweetie” except this variety is extremely productive, less adaptable to various climates and slightly smaller than “Sweetie”. It also should be trellised, produces 65 days from starts. Available from J.W. Jung Seed Co. 800 297 3123.

“Double Rich” - Meaty, juicy four to eight oz scarlet fruit with few seeds. Excellent canned or juiced. High yields 80 days from starts. Has two to four times more vitamin C than most tomatoes. A vigorous vine that's probably best trellised. Has been available from Bountiful Gardens and Territorial Seed Co. #

“Caro Rich” - Delicious, sweet, low acid four to six oz golden orange fruit. About ten times richer in vitamin A (beta carotene) than other tomatoes. High yields 75 to 80 days from starts, even in cooler climates. #

“Burbank” - Fruity flavor with a hint of tartness. Yields well. Richest in available amino acids in trials by Seeds of Change. Bushy plant 1½ to three feet tall, it needs no trellising. Yields 70 to 80 days from starts. #

Other tomatoes:

“Sub-arctic Plenty” - tasty small two oz red fruit. Extremely productive. Very cold tolerant and reliable. A compact plant that ripens early, 50 to 59 days from starts. *

“Ida Gold” - A very tasty gourmet fruit, orange colored, mild flavored, low in acid and weighing two to three oz. High yields over a long period, from 55 to 59 days from starts. A compact plant, very cold tolerant, does well and is very productive in winter greenhouses. *

“Earlrouge” - A sweet, tasty six to seven ounce red fruit that peels easily and is crack free. Good fresh and canned. Cold hardy and sets fruit well even in extreme conditions, yields 66 days from starts. *

“Coldset” - This blood red four to six oz, high yield tomato is unique in its ability to germinate in soil temperatures as low as 50°F. The seedlings tolerate a little frost and may survive to 18°F. Can be direct seeded in spring, rather than grown from starts even in cool mountain climates. It won't do well with heavy summer rains however, as it dislikes excessive wetness and humidity. Yields in 68 days. *

Storage tomatoes:

“Long Keeper” - Red, firm and tasty six oz fruit. High yields 75 days from starts. For storage it is picked when its skin starts turning a soft gold. Place the fruit on open shelves at 60° to 70°F, and they will still taste fresh three months later.

Tomatoes are tender to frost, pick them if frost is expected. Also good canned. *

“Vendor” - Tasty, firm red six to nine oz fruit, yields well. Very disease resistant. Best open pollinated greenhouse variety in trials performed by High Altitude Gardens. Also, these fairly compact plants do extremely well in cold frames. 75 days from starts. *

SUN TRAPS

“Sun traps” using evergreen shrubs can also be used to extend the growing season by creating a warmer micro-climate within a mostly enclosed garden area. The micro-climate is created through the shrubs' release of heat, collected from the sun, as the weather turns colder. As long as a problem wind does not come out of the South, sun traps can double as a wind break. Plant them in a horseshoe pattern around the garden, open to the south. Use taller evergreens in the north and lower growing evergreens on the East and West sides to minimize shading the garden.

EVERGREEN SUN TRAP SHRUBS:

Benefits & Uses:

(The USDA climate zones indicate the cold limit of the plants' habitat range.)

Euonymus japonica (zone 7):

harbors beneficials, edible young leaves.

E. patens var. *Manhattan* (zone 5)

Coffeeberry or California Buckthorn:
Rhamnus californica (zone 7)

harbors beneficials, coffee substitute, nitrogen fixer

Some Ceanothus, two of the most hardy are:

C. thyrsiflorus (zone 7)

C. velutinus (zone 4)

harbors beneficials, bee forage, and nitrogen fixer, flowers and leaves on some species are used for tea and medicinal.

Mountain Mahogany (*Cercocarpus*): nitrogen fixer, bark used as seasoning
C. betuloides (zone 6)
C. ledifolius (zone 4)
C. intricatus (zone 6)

Pineapple Guava (*Feijoa sellowiana*) (zone 7): edible flowers and fruit

Loquat (*Eriobotrya japonica*) (zone 7): edible fruit, because it begins to bloom in winter, it often produces no crop in the colder part of its range. When it does produce, however, it often yields abundantly.

Chilean Guava (*Ugni molinae*) (zone 8): edible fruit

Tall Oregon Grape (*Mahonia aquifolium*) (zone 5): edible fruit, medicinal root

Mexican Orange (*Choisya ternata*) (zone 7): bee forage

Green Leaf Manzanita (*Arctostaphylos patula*) (zone 5): medicinal

Buffaloberry (*Shepherdia rotundifolia*) (zone 5): edible fruit, nitrogen fixer

Four Wing Saltbush (*Atriplex canescens*) (zone 4): harbors beneficials, edible young leaves, fire resistant

Shrubby Junipers (*Juniperus spp*): medicinal, gin
(zones vary by type, there are junipers for almost every climate that's temperate)

Pacific Wax Myrtle (*Myrica californica*) (zone 7): nitrogen fixer, medicinal, wax

Dwarf Olives (*Olea europaea*) (zone 7): edible fruit & leaves, medicinal

<u><i>Gardenia jasminoides</i></u> (zone 8):	edible flowers- fresh, pickled, preserved in honey, mixed with tea for jasmine tea
<u>Sugar Bush (<i>Rhus ovata</i>)</u> (zone 8):	edible fruit, waxy fruit coat used as a sugar substitute
<u>Myrtle (<i>Myrtus communis</i>)</u> (zone 8):	leaves, flowers & flower buds as a spice, medicinal
<u>Coast Silk Tassel (<i>Garrya elliptica</i>)</u> (zone 7): (<i>G. fremontii</i>) (zone 6)	none known
<u>Cliff Rose (<i>Cowania mexicana</i>)</u> (zone 5):	foliage for tea, fiber, dye, medicinal
<u>Antelope Brush (<i>Purshia tridentata</i>)</u> (zone 4):	medicinal, bee forage, dye
<u>Toyon (<i>Heteromeles arbutifolia</i>)</u> (zone 7):	edible fruit, bee forage, fire resistant
<u>Huckleberry (<i>Vaccinium ovata</i>)</u> (zone 7):	edible fruit (takes full sun only where summers are cool)

PERENNIAL PLANT PROPAGATION

Seed must be dried, drying rates vary by species. Place them in paper bags in a hot, dry place. After drying, some seeds may need to be cleaned. Seeds can be rinsed in hydrogen peroxide to sterilize them against seedling diseases.

Once pretreatment is complete, place seeds between nursery blotter paper and lay on a nursery flat. Keep continuously moist, using a mist head works best. Put whole flat in a clear plastic bag. When this seed has germinated it can be potted.

Deep pots are best because they allow for unrestricted root growth. A root to shoot ratio of ten to one is ideal, especially for dryland plants.

Deep plastic pots for seedlings can be purchased, or cheap plant containers can be made from newspaper. Roll newspaper into a cylinder so it is 11½ inches high and has a three inch diameter opening in the center. Wrap the newspaper cylinder with polyvinyl food wrap. Fill with soil mix and plant.

At the end of eight to twelve weeks, roots should have reached the bottom of the paper cylinder. At this point, the plants now can be hardened off (reduce amount of water added) outside in the shade and then planted out, or they can be stepped up to a larger pot. These plants will require irrigation for establishment once planted in their permanent locations. When planting the small newspaper cylinders out permanently, remove the plants with great care, score roots and massage as needed. In order to slip the plants out of their pots, you may need to turn the plant upside down and tap the edge of the pot rim on something solid. These plants should receive modest irrigation during the first one to two years to get established, where possible.

IRRIGATION SYSTEMS

There are three different types of irrigation systems that are used according to the site requirements and design. Low pressure systems, high pressure systems and flood systems are all used variably, though flood irrigation is the least often used system, commercially or domestically.

The most efficient way to irrigate is to use a moisture sensor or tensionmeter that can determine the actual water needs of the planting. This will eliminate both over- and under- watering. All irrigation should water deeply, and then turn off to prevent salting of the soil (frequent, light watering can cause mineral salts in the soil to accumulate near the surface), especially in arid and semi-arid environments.

Low-pressure systems deliver water at a much slower rate than high-pressure systems, and so irrigation time is longer in duration. High-pressure systems using central pivot, high impact heads, rainbirds or pop ups tend to be the least efficient. Central pivot irrigation is most wasteful because of the way it's used, as well as the method of water distribution. Often used in commercial agriculture to water large, open (and often windy) areas, the water delivery system is so high off the ground that most water blows off slowly without reaching the plants and soil.

LOW PRESSURE

Drip irrigation systems water slowly, whereas high-pressure systems can water faster than water can be absorbed, resulting in runoff. Clay is very slow to absorb water, and higher runoff is possible; water three times a day rather than once or over two to three days.

A low-pressure irrigation system is significantly less expensive and more water efficient than high-pressure systems, and distribution and infiltration are much better if the low-pressure system is well planned. The main line of a low-pressure system is installed at the same time as the high-pressure system and the same line can be used for both. The low-pressure (drip) lines are installed after or during the planting stage.

There are numerous options for irrigation heads with a low-pressure system, from drip emitters to jet sprayers. Where drip emitters put water down in one small space, jet sprayers can cover an area up to eighteen foot diameter completely. Drip emitters are only recommended for the occasional isolated herbaceous perennial; however, since most plantings should have ground covers covering the soil, some form of spray head is used instead. There are spray

heads and jet sprays for almost any situation. Unlike a high-pressure system, the secondary lines and “spaghetti” are buried shallowly.

The system must be drained at the end of each growing season, and so a drain line is needed at the lowest point in the terrain. A compressor is typically used (depending on the scale of the site) to blow out all of the water in the lines to prevent broken or cracked pipes from freezing over winter. The whole hybrid system can be set up on a timer so watering can be automatic and easily adjusted as needed from one location (at the timer box).

HIGH PRESSURE

The ideal site for the high pressure/high riser system is in orchards. The rest of the garden can be on a low-pressure system, or in some cases, hose irrigated from a frost-free. A high-pressure system is installed before planting commences, but after the general finishing grade is completed (See Eco-Orcharding). High pressure systems are the most expensive and least efficient of the two (high and low pressure), but last longer, require less maintenance, and put out a much greater volume of water in a shorter period of time.

Commercial orchards in cold climates which are often subject to late frosts use high-pressure systems not only to irrigate by mimicking rainfall, but also to protect crops from loss due to frost damage. Typically in this scenario rainbird sprinkler heads are set on high risers, which are pipes eight feet or more high; when spring frosts threaten, the rainbirds are replaced with foggers or misters. The fogger moistens the tree and shrub crop foliage thoroughly and when it freezes, forms an insulating blanket of ice that traps warmth in the plant and blocks cold from penetrating.

When fogging for frost protection, add liquid kelp concentrate to the irrigation water. Kelp kills off the bacteria that surround the plant cells. These particular

microbes act as a nucleus for ice formation and the ice crystals develop sharp points that puncture the cell walls. Once the cell wall is penetrated, cold can enter and kill or damage plant tissue. This protection only lasts a few days, and if need be can be repeated. On high risers, the rainbirds can also provide an insulating ice layer to the plants, but this ice will be more abundant and thicker, and in some weather events may be preferable, while not in others.

FLOOD SYSTEMS

Flood irrigation is most efficient if used on dead level (flat) land. If the land is uneven, some plantings receive too little water while others receive too much as water pools in the lowest areas on the site. Laser cat operators have attached laser leveling to create flat terraces or fields for best results.

IRRIGATION TIPS

On site, soil drainage testing is essential to determine how much or often to water, and how deeply. To test soil drainage, dig holes 1½ feet across and one to 1½ feet deep, fill with water and let drain. If the hole drains in less than one hour, the drainage is good; if it drains in up to 24 hours, the drainage is slow or poor and should be watered more often for shorter durations. In all cases, deep irrigation is recommended with longer intervals between waterings, in order to minimize the irrigation needs of plants and curtail salt build-up. Observation and adjustments will be needed.

The best times to irrigate are just before sunset through to 9 am, when the roots are most actively taking up moisture. During windy periods, delay irrigation until it calms down if possible. From 9 am to near sundown, evaporation is highest and roots are near dormancy, so irrigating is inefficient.

By September, plant growth slows in preparation for winter, and is encouraged by “hardening off”, or reducing the irrigation. After establishment, in many areas irrigation can be turned off completely during September, depending on the weather. Withholding irrigation at this time will increase winter hardiness.

Other ways to make the best use of existing water resources can be designed in. Increasing the soil's humus content will reduce moisture loss from evaporation, run-off and subterranean drainage. Returning the bulk materials left after alcohol extraction to the soil, is, for this reason, very important. Certain intermediate uses for the ethanol feedstock waste will increase its value as a soil builder greatly (more on this in Alternative Technologies). Mycorrhizae fungal inoculation dramatically increases a plant's ability to consume available moisture as well as uptake essential nutrients in solution, particularly phosphorous. In addition, root associations with mycorrhizae increase the plants resistance to pests, disease and particularly root pathogens. Among the various species of mycorrhizal fungi are edible and/or medicinal mushrooms, which if harvested could increase the project's income. Mycorrhizae are essential for sustainability (See Fungi).

FROST-FREE FAUCETS

Frost free faucets should be used in areas subject to hard freezes over winter. These frost-resistant faucets should be on a different water mainline than the hybrid irrigation system so they can be used during the winter (when the irrigation system is drained and turned off). Extended dry periods in the winter can prove fatal to plants, particularly a new planting, but also for plants poorly adapted to drought. Some winter watering may be needed in any given year depending on climate and plant.

Frost frees are useful for establishing plants that are drought tolerant, and those in the wetlands that will need minimal irrigation once established. Using hoses, plantings can be watered with sprinklers, either oscillating or stationary. A

battery-operated timer can be attached to the frost free hose bib so you don't have to keep track of when to turn it off.

Frost frees should stand three to four feet above ground level for convenience. Wrap the pipe stand to insulate it. A "Y" connector can be attached to the frost free faucet or to the timer so two hoses can be run off the same faucet. The only kind of hoses I've ever recommended are 100% rubber because they are light weight, kink-proof, and are easy to work with even in winter.

FINAL IRRIGATION NOTE

An ideal irrigation system should be developed so it's possible to switch from the well or house water source to the nutrient-rich water of the pond occasionally. A filter is important when using pond water.

Natural vs Industrial Farming

1. Chemical / Industrial farming (called 'Green Revolution' farming) uses up to ten calories of purchased energy input to produce one calorie of food energy. The natural farming methods of traditional cultures (called primitive farming) use one calorie of input energy to yield just over one calorie of food energy. In addition to the extraordinary cost to the industrial farmer for fuel, fertilizer, herbicides, equipment, etc, they are also destroying the land, water and air. *The Salina Journal* (9/9/96) Jim Scharplaz, contributing editor.
2. Between 1950 and 1992, consumption of fossil fuel by agriculture increased seven-fold worldwide. *The Land Institute Newsletter* (10/30/92).

3. Between 1945 and 1993, pesticide use in the US increased by 3,300%. During that same period, crop loss to pests increased 20%. *Health and Fitness Connection* (8/93).
4. A child between the ages of one and five accumulates six to twelve times more pesticides in their body from the food they eat than do adults. *San Francisco Chronicle* (5/16/88).
5. Children living in homes with yards treated with herbicides and pesticides are four times more likely to develop cancer of the soft tissues than children living in homes with untreated yards. *American Journal of Public Health* (1995).
6. Remember Alar? A discontinued pesticide used on apples, it increases a child's risk of cancer by 240%! *US News & World Report* (3/13/98).
7. The Environmental Protection Agency (EPA) has only banned a small percentage of known carcinogenic pesticides. The rest are still widely used on American and international food crops. In the early 1990's the EPA themselves stated that they only test about 7% of new herbicides and pesticides. If a pesticide or herbicide is banned by the EPA for being carcinogenic, the manufacturer can just add a few other chemicals to it, rename it and send it through again. *The New Mexican* (7/26/92).
8. Two neighboring farms near Spokane, WA with almost identical conditions show the contrast between chemical & industrial agriculture and organic agriculture. One farm was first developed in 1908, the other in 1909. Up until 1948 the two farms had been using natural methods of farming, integrating crop rotation and such. After this point, one farm began using the recommended amounts of chemical fertilizers and pesticides by extension agents.

While the one farm had switched to chemical farming, the other had

- continued to use organic methods and no chemicals. In 1988 a comparison study was made between the two farms. It was found the organic farm had an average of six inches more topsoil than the one farmed with industrial means. The organic farm's soil had a softer surface more resistant to crusting over and it had a higher moisture holding capacity, owing no doubt, to the greater amount of organic matter. In addition, the organic farm's soil was richer in beneficial enzymes and had significantly larger beneficial microbial communities. *Mother Earth News*, (Jan/Feb 1988).
9. Small bio-intensive farms are 200% more productive agriculturally per acre than industrial / conventional farms. *Pacifica Network News, Food First*, Francis Moore Lappe (12/14/99).
 10. Traditional Asian agriculture, considered greatly more productive than industrial agriculture, feeds seven people year round, per acre. *National Public Radio, All Things Considered* (1/18/87).
 11. In many undeveloped countries, an acre of land must feed about five people. An acre in the US agri-business feeds an average of a fraction over one person. *The Book of Bamboo*, David Farrelly Sierra Club Books, 1984.
 12. In the highlands of Guatemala, the traditional agriculture system of the Maya produced enough food to feed a family year round with just a month and a half of labor. The primary crops in their system were corn, beans and squash planted in guilds. *Whole Earth Review*, Fall 1991, "Mayan Cultural Resurgence" by Jeanne Carstensen.
 13. In highland Peru at 12,000 feet, a 2,500 year old traditional chinampa, or raised field agriculture, has been revived. This ancient system builds large beds about three feet high, the excavated site surrounding the beds is filled with water to protect crops from animal predation and create a micro-

climate that minimizes frost damage. Corn and grains like quinoa and canihua are also primary crops grown in the chinampas.

Aquatic weeds in the water filled canals are the only fertilizers used and fish can be raised in the canals. Even without the fish, this system feeds about fifteen people per acre year round and this is at 12,000'! The chinampas produce an average of ten and up to sixteen metric tons of potatoes per hectare, 50% of which is filled with water, while industrial potato production in Peru yields an average of one to four metric tons per hectare. *Organic Food Matters (The Journal of Sustainable Agriculture)*, vol.11 #1 Spring.

14. In a very impoverished region of India, a small city of Ananda Nagar (City of Bliss), reintroduced traditional East Indian agriculture, with the addition of common organic farming practices like intercropping, around 1970. This switch from industrial farming to organic sustainable farming has increased productivity 400%.

The intercropping of new cash crops like coffee, tea, grapes and rubber trees allows villagers grow all their own food and also derive and income from the land. The yield of a single rubber tree provides and income equal to the average yearly wage of an Indian farmer. *Simply Living*, vol. 5, #4

15. In Vershire, Vermont, long time organic farmer Eliot Coleman developed a polyculture system at the Mountain School where he is the farm manager. His system feeds about 40 people per acre, yet about the only input he pays for is rock phosphate.

16. Masanobu Fukuoka produces enough rice and winter grains on his ¼ acre farm to feeds five to ten people a year. Using his system of natural farming, all organic, it requires only about six days' work for one person to achieve these yields. In addition, his ¼ acre farm produces an abundance of fruit and vegetables. Using his natural farming system, an acre of

farmland could feed 20 to 40 people with a mere 24 to 25 days labor for one person.

Permaculture which uses Fukuoka's natural farming system, combined with ecological innovations such as three dimensional planting (stacking) and biotones (edge effects) can produce even more food per acre. *One Straw Revolution*, Masanobu Fukuoka, Rodale Press, 1978.

17. In the US in 1860 there were about 30 million people, 90% of whom worked in farming or jobs directly related to farming. 100 years later in 1960, the US population had grown to 200 million people, yet only about 8% of them were working on farms. By 1994, less than 2% of US citizens worked in agriculture. The occupation was officially removed from the census for the 2000 census. *Sociology in a Changing World*, William Kornblum (1994).

18. At the time of the Louisiana Purchase in 1803, 90% of Americans were engaged in agriculture. By 1989, the number of people working in agriculture had dropped to just 2½%. *Whole Earth Review*, Spring 1989.

19. In the mid-19th century, Americans grew 30% of their food at home. By 1987, Americans were growing a mere 2% of their food at home. *Harrowsmith*, Sept/Oct 1987.

20. Between 1970 and 1996, over 15% of US farmland had been taken out of production. In 1987, farm foreclosures averaged 180 per day. This increased through the 1990s. *National Public Radio, All Things Considered*. (1/14/96).

21. In 1950, the world produced 624 million metric tons of grain using fourteen million tons of fertilizer. That's 46 tons of food for every ton of fertilizer. By 1985 only thirteen tons of food was produced from each ton of fertilizer.

From Deep Design by David Wann, according to the Nebraska Sustainable Agricultural Society.

22. When anthropologists resurrected pre-Columbian agriculture systems in Bolivia, yields increased seven-fold.

23. Between 1992 and 1997, 13,441 American farms and 13.7 million acres of farmland were lost. In the same period, property values of farms increased 28%. *Common Ground*, May/June 1999.

RECOMMENDED READING:

Carr, Anna. Good Neighbors: Companion Planting for Gardeners. Rodale Press, 1985.

Coleman, Eliot. Four Season Harvest: Organic Vegetables from Your Home Garden All Year Long. Chelsea Green Publishing, 1999.

Gardener, Jo Ann. Living with Herbs: A Treasury of Useful Plants for the Home and Garden. Countryman Press, 1997.

Hunter, Beatrice T. Gardening without Poisons. Houghton Mifflin Company, 1973.

Jeavons, John. How to Grow More Vegetables and Fruits, Nuts, Berries, Grains and Other Crops Than You Ever Thought Possible on Less Land Than You Can Imagine. Ten Speed Press, 2006.

Rodale, Jerome Irving. How to Grow Vegetables and Fruit by the Organic Method. Rodale Press Inc, 1961.

Stout, Ruth. How to Have a Green Thumb Without an Aching Back. Simon & Schuster, 1987.

Walters, Charles. Weeds: Control without Poisons. Acres U.S.A, 1999.

Yepsen, Roger B., ed. Organic Plant Protection: A Comprehensive Reference on Controlling Insects and Diseases in the Garden, Orchard and Yard-Without Chemicals. Rodale Press, Inc., 1976.

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