Basic Seed Saving
By Bill McDorman

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The Magic of Seed Saving

We invite you to rejoin a ritual as old as civilization, a ritual in many ways responsible for civilization. Eons ago, a tribal farmer found a corn cob slightly larger than a fingernail. This farmer took care to save the seeds from the largest and best ears, plant them and harvest anew. There is no way to count the number of times this ritual took place before corn was harvested in its modern sizes, shapes and colors. When a gardener plants his own open-pollinated seeds, he is passing on the ageless, priceless gift bestowed upon him.

The Rewards of Seed Saving

Anyone, with little more work and attention than it takes to grow a home garden, can begin to re-elevate the gardening experience to a sustainable level. My wife and I were inspired by our trip to Siberia where thousands if not millions of people from all walks of life save all their own garden seed. In fact, seed saving in Siberia is an integral part of the gardening experience. In common with gardeners everywhere, competition for the best garden harvest is intense. The difference is that the best varieties we saw resulted from years of selective seed saving and not from packets of purchased seeds. Without any background in genetics, Siberian gardeners tap into the rewards of seed saving by "selecting" seeds from only those plants or flowers that exhibit desirable characteristics. This selection process is a powerful technique used to create new varieties. Gardeners design simple selection experiments by planting the same variety in different environmental conditions or by planting different varieties in the same environmental conditions.
Our friend Dima who lives in Novosibirsk, Siberia grows watermelons. Al though most knowledgeable agricultural experts in Siberia will tell you that water melons do not grow in Siberia, Dima, after several

years, produced a single, small, tennis ball-sized fruit. He carefully saved the only two seeds produced by the melon and planted them the following spring. Success again. Dima saved several seeds from the largest fruit. When we met Dima ten years into his "melon adventure" his garden was consistently producing kilo-sized melons. Dima simply saved seeds from the melons that survived in his garden. He created a unique, new treasure. He contributed to genetic diversity. And important to Dima, fresh watermelons are his to enjoy each short, Siberian summer.

The Importance of Seed Saving

We are on the verge of losing in one generation, much of the agricultural diversity it took humankind 10,000 years to create. As late as 1900, food for the planet's hungry was provided by as many as 1,500 different plants, each further represented by thousands of different cultivated varieties. Today over 90% of the world's nutrition is provided by 30 different plants and only four (wheat, rice, corn and soybeans) provide 75% of the calories consumed by man. Where once diverse strains strengthened each local ecosystem, currently, a handful of "green revolution", super-hybrid varieties are "mono-cropping" farms and gardens worldwide.
Because diseases or pests eventually attack individual varieties, the strength of any ecosystem is a function of its diversity. If one variety of potato is planted, as was done in Ireland in the early 1800's, the result is likely to be its loss. The Irish potato famine could have been averted if many different varieties of potatoes had been planted. In 1970, 50% of a genetically uniform corn crop in the Southern United States worth more than a billion dollars was lost to a single disease. Today, potatoes are grown in Ireland and corn in the Southern United States because disease resistant varieties were found and planted. Botanists often look for varieties resistant to new diseases in the "Vavilov centers" or "centers of genetic diversity" where our food crops once originated. These centers around the world are now being planted with the same handful of "green revolution" hybrids. For example, the genetic center for wheat found in Turkey is in danger of being planted completely with hybrids by the end of the decade. Thousands of native and heirloom wheat varieties are disappearing and will be unavailable to botanists looking for varieties resistant to the plant diseases of the future. The modern world is facing the

prospect of feeding hungry billions with a genetically uniform agriculture and little or no diversity to sustain it.
For approximately 10,000 years, individual gardeners and farmers created and sustained our rich genetic heritage. Now gardeners and farmers can play an important role in saving it by learning to save their own seeds from varieties that perform best in their own mini-ecosystems. This will assure diversity in the same the way that diversity was promoted and protected instinctively throughout the history of agriculture.

Basic Terms

This online guide was designed to limit the need for complicated genetic terms. The following terms provide a basic understanding of seeds and seed production.
Seeds are living, hibernating embryos. They have a life span and survive longest if kept cool, dark and dry.
Flowers are the portions of plants where reproduction takes place and seeds are produced.
Pistils are the female reproductive organs in flowers made up of the stigma, style and ovary. The stigma is the opening in the pistil through which the pollen passes on its way to the ovary. The style contains the pollen tube between the stigma and the ovary through which the pollen is carried. The ovary contains ovules. When fertilized, ovules develope into mature seeds.
Stamens are the male reproductive organs in flowers. They consist of the filament, anther and pollen. A filament is the tube that supports the anther where pollen is produced. Pollen is the equivalent of sperm in plants. Pollen grains fertilize plant ovules.
Pollination is the process of sexual fertilization in plants. The different methods a flower uses for pollination will dictate the spacing or isolation necessary for plants to produce dependable seeds.
Self-pollination occurs without need for other flowers or plants because it takes place within the flower before it opens. Isolation distance to prevent cross -pollination is not necessary unless insects invade the flowers.
Perfect flowers contain the stamens which produce pollen and the pistil which receives the pollen. Some self-pollinate. Others are self-incompatible, meaning they will not receive their own pollen.

Cross-pollination takes place when pollen is exchanged between different flowers on the same or different plants. If not prevented, unwanted characteristics and traits may result in the offspring. Isolation distance to prevent unwanted cross-pollination is the distance between two different flowers necessary to prevent pollen from being exchanged. Wind pollination is pollen exchange caused by wind and insect pollination is pollen exchange caused by insects, primarily bees.
Hybrids are varieties resulting from pollination between genetically distinct parents. The "F" in F1 hybrid stands for filial, another name for offspring. F1 means the first generation offspring after pollination. Depending on their genetic complexity, F1 Hybrids can be sterile or produce a majority of offspring unlike themselves.
Open-pollinated varieties are stable varieties resulting from the pollination between the same or genetically similar parents. Not hybrid.
Monecious plants produce single plants with separate male flowers and female flowers on the same plant.
Dioecious plants produce separate male flowers and female flowers on different plants.

Headings

Look here for definitions of the headings used for each vegetable.
PLANT: The separation distance between plants necessary for successful seed production is given under this heading for each vegetable. Techniques to prevent cross-pollination other than by separation distance are also suggested.
Caging is a separation technique where insects that might cause cross-pollination are prevented from reaching flowers by a fine net supported by wire or wood. If flowers in the cage are not self-pollinating, several plants must be included in the cage and pollinating insects introduced. Alternate day caging allows two plants or two groups of plants to be naturally pollinated by insects. Unwanted cross -pollination is prevented because one plant or group of plants is caged one day and the other plant or group is caged the next.

Root to seed describes a technique used to produce seed for biennial crops. The roots of the biennials are harvested in the fall, trimmed

and stored for the winter. The following spring, the best roots are planted for seed production that season. When roots to biennials are left in the ground in the fall to produce seeds the following summer, the term seed to seed is used.

FLOWER: A complete description of each vegetable's flower type and pollination method is given.

INBREEDING DEPRESSION: This section alerts gardeners to the possibility of a loss of vigor because of inbreeding. Vigor is a desirable characteristic that describes strong, vibrant germination and plant growth. Inbreeding can result from self-pollination or pollination between a small number of close relatives. Some vegetables show no signs of inbreeding depression even when self-pollinated for many generations and others show signs of inbreeding depression in first genera tion offspring.

SELECTION TRAITS: In the interest of clarity we make a distinction between selection characteristics and selection traits.
Characteristics are general features attributed to unidentified complexes of genes. Complex and hard to define, characteristics are often ignored by commercial breeders and offer the most rewards for home gardeners. Characteristics on the priority list at ISSI include but are not limited to freeze tolerance, cold tolerance, regional adaptability, winter hardiness, early maturation, vigor and flavor. Each home gardener can create his or her own list of selection characteristics.
Traits are specific features traceable to identifiable genes. For example, pea traits traceable to single genes include vine growth (bush or tall), seed texture (smooth or wrinkled) and disease resistance (fusarium, enation mosaic and powdery mildew resistance).
Dominant trait, abbreviated "D", is the variation of a specific gene that results in observable traits. For example, in bachelor's buttons blue is the dominant color. Seed harvested from multi-colored stands that have been allowed to cross-pollinate is likely to produce plants with a majority of blue flowers.
Recessive trait, abbreviated "r", is variation of a specific gene that results in observable traits only if the dominant variation is not

present. For example, wrinkled pea seeds only result when the dominant, smooth-seed trait is missing.

HARVEST: Successful production of seeds may require a growing season several weeks longer than the successful production of an individual vegetable or flower. Plan accordingly. For example, start plants indoors and design a strategy to allow enough time before frosts for the maturation of seeds.
Viable seeds are seeds that germinate and produce vigorous plants. Seeds should not be harvested before they have matured enough to be viable.
Dehiscent seed capsules are open and discharging seeds. Seeds must be harvested before this stage takes place and seeds are lost. Seed capsules in some varieties literally explode at the point of maturity. It is not uncommon to have only a few capsules out of hundreds, mature at any one time.

PROCESS: Cleaning and separating seeds from chaff is not difficult or even necessary for small, home garden needs. Often, a little extra time taken during harvest to shake seeds out, one capsule at a time, results in completely clean seeds that need no processing.
Thresh is a term used by seed professionals to describe the process of separating seeds from chaff, small, remaining pieces of pods or coverings.
Flail is the process of fracturing or crushing seed pods in order to free the seeds. This can take the form of everything from simply rubbing broccoli pods between hands to walking over bean vines.
Winnow is an ancient technique used to clean seeds. Seeds and chaff are poured through moving air which blows the lighter chaff aside, allowing the heavier seeds to be collected below.
Cleaning Screens with different-sized openings are used to separate seeds from chaff. The screen number denotes the number of openings that will cover a one inch line. A screen is selected with openings just large enough to let seeds drop through without the chaff or as in the case of larger seeds, a screen selected to allow the chaff to drop through without the seeds. (See page 36.)

STORAGE: The successful storage of seeds demands cool, dark, and dry condi tions. Put seeds in plastic bags for separation and labeling before putting the plastic bags into air-tight, glass jars to be

stored. Note: plastic bags alone do not protect against moisture, especially in potentially moist locations like refrigerators or freezers. Allow jars that have been stored in refrigerator or freezer to warm to room temperature before opening to prevent moist air from condensing on the inside walls of the jar.
Cool: At the National Seed Storage Laboratory in Ft. Collins, Colorado, some seeds are stored at 400° F. below zero. However, generally, storage conditions are adequate if seeds are kept below 50° F.
Dark: Absolute darkness is best. However, seed storage is adequate if direct sunlight or bright, artificial light is avoided.
Dry: Dryness is the most important factor in the long-term storage of seeds. Opti mum levels should be below 9% moisture. Most vegetable and flower seeds will store more than one year without special protection. Silica gel can be purchased for prolonged storage in humid climates.

Beginner

Bean, Lettuce, Pea, Pepper, Tomato.
These vegetables offer the beginning seed saver the best chance for successful seed saving. They produce seed the same season as planted and are mostly self-pollinating, minimizing the need to be mindful of preventing cross-pollination.

Bean - Phaseolus vulgaris

PLANT: Although, ideally, different varieties should be separated by 150 feet or another crop flowering at the same time, we rarely observe cross-pollination even when two varieties are grown next to each other.
FLOWER: Beans produce perfect, self-pollinating flowers. Cross pollination by insects is possible but rare as pollination occurs before the flower opens. Because the anthers are pushed up against the stigma, automatic pollination is assured when the anthers open.
SELECTION TRAITS: Most commercial breeders favor bush varieties which can be mechanically harvested and fibrous bean pods which hold up during harvest and shipment. Pole varieties are more suited to small, home gardens because they produce more beans in a smaller space. Because vines are off the ground beans are easier to

pick and away from the settling cold air of unexpected frosts. Plant growth: Pole type growth, D; Bush, r. Pod edibility: Little or no fiber, r; Stringless, r . Seed color: White seeded varieties are better for canning because seed color doesn't affect canning liquid, r; Colored, D. Pod, foliage and flower color: Purple, D.
HARVEST: Allow pods to dry brown before harvesting, about six weeks after eating stage. If frost threatens, pull entire plant, root first, and hang in cool, dry location until pods are brown.
PROCESS: Small amounts of pods can be opened by hand. Flail larger amounts. Remove large chaff by hand or fork. Winnow remaining particles.

Lettuce - Lactuca sativa

PLANT: Separate varieties flowering at the same time by at least 20 feet to ensure purity.
FLOWER: Lettuce produces perfect, self-pollinating flowers. Each flower produces one seed. Flowers are grouped in little heads of 10-25 flowers all of which open at once for as little as 30 minutes. Anthers are fused together into a little cone that completely surrounds stigma and style. Style is pushed up through anther cone and is coated with its own pollen. Note: Mature head lettuce may need a slit (two or three inches deep) across the top to encourage flowering.
SELECTION TRAITS: Leaf color: red, D. Leaf color is controlled by at least two genes with a number of variations possible. Generally, hybrids produced by crossing red and green varieties result in red offspring. Leaf shape: no lobes, D; oak leaved, r. Seed stalk formation : bolt resistance, r;
Seed color: white seeds, r; black seeds, D.
HARVEST: Some outside leaves can be harvested for eating without harming seed production. Allow seed heads to dry 2-3 weeks after flowering. Individual heads will ripen at different times making the harvest of large amounts of seed at one time nearly impossible. Wait until half the flowers on each plant has gone to seed. Cut entire top of plant and allow to dry upside down in an open paper bag.
PROCESS: Small amounts of seed can be shaken daily from individual flowering heads. Rub with hands to remove remaining seeds. If necessary, separate seeds from chaff with screens.

Peas - Pisum sativum

PLANT: Ideally, different varieties need to be separated 50 feet or with another crop flowering at the same time. However, in the cool regions of the Rocky Moun tains, we rarely observe cross-pollination even when two varieties are grown next to each other.
FLOWER: Peas produce perfect, self-pollinating flowers. Cross-pollination by insects is possible but rare because pollination occurs before the flower opens. Because the stigma does open before pollen is ready crosses theoretically could occur.
SELECTION TRAITS: Most commercial breeders prefer bush varieties with pods that ripen simultaneously in order to facilitate commercial harvesting. Tall varieties produce more peas in small, home gardens. Plant Growth : tall, D; bush, r. Seed Shape: Round seeds germinate better in cold weather, D; w rinkled seeds, r. Pod Edibility: lack of fibers on the inside of the pod, r. Pod shape: round, D;
flat, r.
HARVEST: Allow pods to dry brown before harvesting, about four weeks after eating stage. If frost threatens, pull entire plant, root first, and hang in cool, dry location until pods are brown.
PROCESS: Small amounts of pods can be opened by hand. Flail larger amounts. Remove large chaff by hand or fork. Winnow remaining particles.

Pepper - Capsicum annuum

PLANT: Most home gardeners will get satisfactory results if different varieties are separated by 50 feet and another tall, flowering crop. New studies from New Mexico State University show more crossing than was previously thought. We recommend at least 400 feet between varieties to ensure absolute purity.
FLOWER: Peppers produce perfect, mostly self-pollinating flowers. Solitary bees will pollinate if a more desirable pollen is not available in the area.
SELECTION TRAITS: Flavor: Hot, D
HARVEST: Harvest mature, fully-ripe peppers for seed. (Most bell peppers turn red when fully mature.) If frost threatens before peppers mature, pull entire plant and hang in cool, dry location until peppers mature.

PROCESS: There are two methods, dry and wet, to process pepper seeds. The dry method is adequate for small amounts. Cut the bottom off the fruit and carefully reach in to strip the seeds surrounding central cone. In many cases, seeds need no further cleaning. To process the seed from large amounts of peppers, cut off the tops just under the stem, fill a blender with peppers and water and carefully blend until good seeds are separated and sink to bottom. Pepper debris and immature seeds will float to the top where they can be rinsed away. Spread clean seeds on paper towel and dry in cool location until seed is dry enough to break when folded.

Tomato - Lycopersicon esculentum

PLANT: Separate varieties with short styles (most modern varieties) by at least 10 feet. Varieties with long styles (heirlooms and older varieties) need at least 100 feet to ensure purity. If solitary bees are prevalent, separate all varieties at least 100 feet and place another flowering crop between.
FLOWER: Tomatoes produce perfect, self-pollinating flowers. Anthers are fused together into a little cone that rarely opens until pollen has been shed and the stigma pollinated. (Older varieties with wild tomatoes or L. pimpinellifolium in their genetic ancestry may have stigmas that stick out beyond the cone containing the anthers. Varieties with this trait can be identified by looking closely at mature flowers and need to be treated accordingly.)
SELECTION TRAITS: Tomato is the most popular vegetable in America and hundreds of the genes have been mapped. Those of immediate importance for home gardeners include: Plant size: Determinate varieties, r; b ush varieties, r; dwarf varieties, r. Leaf Shape : Potato-type leaves, r. Disease resistance : Leaf mold resistance, r; fusarium wilt, race 1 and race 2, D; verticillium wilt, D; alternaria, D; tobacco mosaic, D; nematodes, D. Ripening : prevents green shoulders, r; prevents ripening and is found in Longkeeper, r; produces parthenocarpic fruits which do not need to be pollinated. Tomatoes without seeds can be produced in weather too-cold for pollination to take place, r. Fruit color - produced by the combination of flesh and skin colors:
red: pink flesh, r covered by a yellow skin, r
pink: pink flesh, r and colorless skin, r
crimson: bright, purplish-red flesh, r and yellow skin, r

purple: bright, purplish-red flesh, r and colorless skin, r;
yellow: yellowish flesh, r and yellow skin, r
white: yellowish flesh, r and colorless skin, r
orange: reddish-orange flesh, D and yellow skin, r
HARVEST: If possible, allow tomatoes to completely ripen before harvesting for seed production. Unripe fruits, saved from the first frost, will ripen slowly if kept in a cool, dry location. Seeds from green, unripe fruits will be most viable if extracted after allowing the fruits to turn color.
PROCESS: Cut the tomato into halves at its equator, opening the vertical cavities that contain the seeds. Gently squeeze out from the cavities the jelly-like substance that contains the seeds. If done carefully, the tomato itself can still be eaten or saved for canning, sun-drying or dehydrating.
Place the jelly and seeds into a small jar or glass. (Add a little water if you are processing only one or two small tomatoes.) Loosely cover the container and place in a warm location, 60-75° F. for about three days. Stir once a day.
A layer of fungus will begin to appear on the top of the mixture after a couple of days. This fungus not only eats the gelatinous coat that surrounds each seed and prevents germination, it also produces antibiotics that help to control seed-borne diseases like bacterial spot, canker and speck.
After three days fill the seed container with warm water. Let the contents settle and begin pouring out the water along with pieces of tomato pulp and immature seeds floating on top. Note: Viable seeds are heavier and settle to the bottom of the jar. Repeat this process until water being poured out is almost clear and clean seeds line the bottom of the container. Pour these clean seeds into a strainer that has holes smaller than the seeds. Let the excess water drip out and invert the strainer onto paper towel or piece of newspaper. Allow the seeds to dry completely (usually a day or two). Break up the clumps into individual seeds, label and store in a packet or plastic bag.

Experienced

Corn, Cucumber, Muskmelon, Radish, Spinach, Squash/Pumpkin. The experienced seed saver's vegetables produce seed the season they are planted but require separation to keep unwanted cross-pollination from taking place.

Corn - Zea mays

PLANT: Female corn flowers are pollinated predominately by the wind, rarely by insects. Pollen is light and can be carried great distances. For purity, separate two varieties pollinating at the same time by at least 1 mile. Reasonable results are obtained with separation of 1000 feet.
FLOWER: Corn is monecious, producing separate male and female flowers on each plant. Male flowers appear as tassels on the top of corn stalks and female flowers are pollinated via the silk emerging from each ear.
INBREEDING DEPRESSION: Corn is susceptible to intense inbreeding depres sion. If seed is saved from too few plants, subsequent plants may be short, mature late and produce few ears. Grow at least 200 plants and save the seeds from at least 100 of the best.
SELECTION TRAITS: Although corn genetics have been extensively studied, most meaningful traits are controlled by numerous genes and exact explanations are complicated. The following are general predictions: kernel sweetness:
(su) sweet flavor (wrinkled seed), r
(sh2) shrunken, extreme sweetness (wrinkled seed), r
(se) supersweet, (delays starch formation), r
kernel color: black, D (results in black or blue); c olored, D (over white); white, r. kernel starch : flint, D; sweet corn, r.
HARVEST: Corn seed is usually ready to be harvested 4-6 weeks after eating stage. If growing season is not long enough, pick ears after husks turn brown. Pull back husks and complete drying in cool, dry location.
PROCESS: Process all but very large amounts of seed by gripping dried ears by hand and twisting allowing kernels to fall into container. Any remaining silk and chaff can be winnowed.

Cucumber - Cucumis sativus
(All cucumbers except Armenian cucumbers)

PLANT: Separate two different cucumber varieties by at least 1/2 mile to ensure purity. Experienced, home, seed savers can grow more

than one variety at a time in a single garden by using hand pollinating techniques. (See page 36.)
FLOWER: Cucumbers are mostly monoecious with separate male and female flowers on each plant. Female flowers can be identified by locating the ovary (a small looking cucumber) at the base of the flower. Cucumber vines will produce the greatest amount of female flowers when day length shortens to approximately 11 hours per day. Fruits will be aborted during dry spells and very hot weather.
INBREEDING DEPRESSION: Although inbreeding depression is not usually noticeable in cucumbers, seeds should be saved from at least 6 cucumbers on 6 different plants.
HARVEST: Cucumbers raised for seed cannot be eaten. They should be left to ripen at least 5 weeks after eating stage until they have turned a golden color. First, light frost of the season will blacken vines and make cucumbers easier to find. Undamaged fruits can be stored in cool, dry place for several weeks to finish ripening.
PROCESS: Slice fruit lengthwise and scrape seeds out with spoon. Allow seeds and jelly-like liquid to sit in jar at room temperature for 3 or 4 days. Fungus will start to form on top. Stir daily. Jelly will dissolve and good seeds will sink to bottom while remaining debris and immature seeds can be rinsed away. Spread seeds on a paper towel or screen until dry. (See instructions for tomato.)

Muskmelon - Cucumis melo
Divided below into seven separate groups because of similar features. All C. melos varieties in all groups will cross with each other. They will not cross with watermelons which are Citrullus vulgaris.
Indorus: honeydew, crenshaw, casaba
Conomon: Asian, pickling melons
Dundaim: pocket melon
Cantalupensis: true cantelopes (without netted skin)
Flexuosus: Armenian cucumbers
Reticulatus: Persian melons, muskmelons with netted skin and orange flesh
Chito: orange melon, garden lemon melon

PLANT: Separate two different muskmelons by at least 1/2 mile to ensure purity. Experienced, home, seed savers grow more than one variety at a time in a single garden by using hand pollinating

techniques. (See page 36.) Muskmelon flowers are small and relatively difficult to hand pollinate.
FLOWER: Muskmelons are mostly monoecious with separate male and female flowers on each plant. (Some female flowers have stamens.) Female flowers can be identified by locating the ovary (a small looking melon) at the base of the flower. The early flowers are the most likely to be successfully pollinated and eventually produce seeds.
lNBREEDING DEPRESSION: Not usually a problem with muskmelons.
HARVEST: Muskmelon seed is mature and can be harvested from ripe and ready to eat muskmelons.
PROCESS: Simply rinse seeds clean, dry with towel and spread on board or cookie sheet to complete drying.

Radish - Raphanus sativus

PLANT: Separate different varieties being grown for seed at the same time by at least 1/2 mile to ensure purity. Satisfactory results for home gardeners require no more that 250 feet of separation. As radishes cannot self-pollinate, pollen must be carried by insects from plant to plant. Seed to seed: Mulch in the fall to insure winter survival. The following spring, thin to 9" spacing, leaving those roots that showed no sign of bolting. Root to seed: Harvest roots in fall. Select desirable roots and trim tops to within an inch of the roots leaving small, new leaves. Store at 40° F. in humid location. Replant in early spring at 9" intervals and cover with 1" of soil. Note: Garden varieties of radish will cross with all wild varieties.
FLOWER: Radishes produce annual flowers which require pollination by insects, primarily bees.
HARVEST: Harvest 3' tall stalks containing seeds pods when pods have dried brown. Pull entire plant and hang in cool, dry place if all pods are not dried at the end of the growing season.
PROCESS: Open pods by hand for small amounts of seed. Pods that do not open when rubbed between hands can be pounded with hammer or mallet. Winnow to remove remaining chaff.

Spinach - Spinacia oleracae

PLANT: It is probably best to grow seeds for only one variety of spinach at a time. Commercial seed crops are separated 5 miles or more. Plant early in the spring to allow enough time for seed production which can take 4-6 weeks more than the time required to reach eating stage. Remove plants which bolt first, and thin remaining plants to 8" for seed production. Leave one male plant for each two females to ensure pollination.
FLOWER: Spinach is "dioecious", with male and female flowers on separate plants. Flowers are wind pollinated by spinach's dust-like, powdery pollen which can be carried for miles.
SELECTION TRAITS: Seed shape: prickly, s mooth. Leaf texture: flat, wrinkled.
HARVEST: Some outside leaves can be harvested for eating without harming seed production. If possible, wait until all plants have dried brown. Pull entire plant and hang in cool, dry place if necessary at the end of the growing season.
PROCESS: Strip seeds in upward motion and let them fall into container. Chaff can be winnowed. Use gloves for prickly-seeded types.

Squash/Pumpkin -
Cucurbita maxima varieties with large, hairy leaves, long vines and soft, hairy stems and include: banana squashes, buttercups, hubbards and marrows
Cucurbita mixta varieties with large, hairy leaves, long vines and hard, hairy stems and include the cushaws
Cucurbita moschata varieties similar to C. mixta with flaring stems at the fruit and large, green sepals surrounding the flowers and include: butternuts
Cucurbita pepo varieties with prickly stems and leaves with a hard, five-angled stem and include: acorn squashes, cocozelles, pumpkins, crooknecks, scallops, spaghetti squashes and zucchinis

PLANT: Squashes from different species (see above) can be grown next to each other. Separate different squash varieties in the same species by at least 1/2 mile to ensure purity. (Some crossing between C. mixta and C. moschata has been reported recently. We know of none from our own experience and have concluded that this is a rare event.) Experienced, home, seed savers grow more than one variety

in a single garden by using hand pollinating techniques. Squash flowers are large and relatively easy to hand pollinate.
FLOWER: Squashes are monoecious with male flowers and female flowers on each plant. Female flowers can be identified by locating the ovary (a small looking squash) at the base of the flower. (Some female flowers have stamens.)
INBREEDING DEPRESSION: Not usually noticed in squash and pumpkins.
HARVEST: Squash must be fully mature before harvested for seed production. This means that summer squashes must be left on the vine until outer shell hardens. Allow to cure 3-4 additional weeks after harvest to encourage further seed ripening.
PROCESS: Chop open hard-shelled fruits and scoop out seeds. Rinse clean in wire strainer with warm, running water. Dry with towel and spread on board or cookie sheet to complete drying.

Expert

Beet/Swiss Chard, Cabbage Family, Carrot, Escarole/Frissee, Onion, Radicchio/Endive, Turnip/Chinese Cabbage. The expert gardener's vegetables normally require more than one year for seed production and mandate separation to prevent cross-pollination.

Beet/Swiss Chard - Beta vulgaris

PLANT: Grow seed for only one variety of beet or Swiss chard at any one time. Seed to seed: Mulch first year crop in the fall to ensure winter survival. The following spring, thin to 18" spacing. Root to seed : Harvest roots in fall. Select desirable roots and trim tops 1-2" above root. Store at 40° F. in humid location. Replant in early spring at 18" intervals with tops just showing above the soil.
FLOWER: Beets and Swiss chard produce perfect flowers. Pollen is light and can be carried for miles by the wind.
INBREEDING DEPRESSION: Save seed from at least 6 different beets to ensure genetic diversity and vigor.
SELECTION TRAITS: Root color: red, red with white stripes, pink, gold, and yellow. Root shape: round, cylindrical.

HARVEST: Cut 4' tall tops just above the root when majority flowering clusters have turned brown. Tops can be stored in cool, dry locations for 2-3 weeks to encourage further seed ripening.
PROCESS: Small quantities of seed can be stripped by hand as seed matures. Large numbers of tops can be put into a cloth bag and stomped or pounded. Chaff can be winnowed.

Cabbage Family - Brassica oleracea
Includes broccoli, brussels sprout, cauliflower, cabbage and kale.

PLANT: All vegetables and varieties in this large species will cross with each other. Separate different varieties at least 1000 feet for satisfactory results or at least 1 mile for purity. Caging with introduced pollinators or alternate day caging is also recommended in small gardens. Plants to be left for seed production should be mulched in the fall or carefully dug, trimmed and stored for the winter in humid area with temperatures between 35-40° F. Flowering plants can reach 4' in height and need at least 2' spacing for good seed production.
FLOWER: Members of the B. oleracea species, with the exception of a few early -season broccolis and cauliflowers, require vernalization (cold, winter-like tempera tures for several weeks) before flowering occurs. Flowers are perfect, most of which cannot be self-pollinated. Necessary cross-pollination is performed by bees. The stigma becomes receptive before the flower opens, and pollen is shed hours after the flower opens.
INBREEDING DEPRESSION: Plant at least 6 different plants to protect vigor and ensure a reasonable amount of genetic diversity.
SELECTION TRAITS: Plant characteristics: t all, D; side buds, D. Plant color: purple, green, magenta. Leaf shape: wide, entire, smooth, hairy.
HARVEST: Broccoli, cauliflower, cabbage and kohlrabi heads grown for seed should not be trimmed for consumption. Brussels sprouts, collards and kale can be lightly trimmed for eating without affecting quality seed production. If small amounts of seeds are wanted, allow individual pods to dry to a light brown color before picking and opening by hand. Lower pods dry first followed by those progressively higher on the plant. For larger amounts of seeds pull entire plant after a majority of pods have dried. Green pods rarely produce viable seeds even if allowed to dry after the plant is pulled.

PROCESS: Smash unopened pods in cloth bag with mallet or by walking on them. Chaff can be winnowed.

Carrot - Daucus carota

PLANT: Separate different varieties at least 1/2 mile to ensure purity. (Queen Anne's Lace or wild carrot will cross with garden carrot.) Alternate day caging or caging with introduced pollinators allows two or more varieties to be grown for seed in small gardens. Seed to seed: Plant seeds in mid-summer. Finger-sized carrots are more winter hardy than full-grown carrots. Mulch in late-fall to ensure winter survival. Thin to 30" spacing in the spring. Root to seed: Harvest eating-sized roots in fall for replanting in fall or early spring. Mulch if planted in fall. Clip tops to 1 -2" and store at 35-40° F. in humid location or layered in sawdust or sand. Replant roots with desirable characteristics 30" apart with soil just covering shoulders.
FLOWER: Carrots produce perfect flowers that are cross-pollinated by a number of insects. Flowers are arranged in round, flat groups called umbels. Carrots require vernalization (cold, winter-like temperatures for several weeks) before flowering occurs.
INBREEDING DEPRESSION: Carrots can exhibit severe inbreeding depression. Save and mix seed from as many different carrots as possible.
SELECTION TRAITS: Root color: white, D; black, orange, purple, red, yellow, r. Root shape : tapered, triangular, round, stubby.
HARVEST: For small amounts, hand pick each umbel as it dries brown. Large amounts of seed can be harvested by cutting entire flowering top as umbels begin to dry. Allow to mature in cool, dry location for an additional 2-3 weeks.
PROCESS: Clean small amounts by rubbing between hands. Larger amounts can be beaten from stalks and umbels. Screen and winnow to clean. Carrot seed is naturally hairy or "bearded". Debearding in the cleaning process does not affect germination.

Escarole/Frissee - Chichorium endivia

PLANT: Separate different varieties at least 1/2 mile to ensure purity. Caging with introduced pollinators allows two or more varieties to be grown for seed in small gardens. Cages must be left on for entire flowering season. Although C. endivia is a biennial, cold, short days

during the first spring will sometimes cause bolting. See: radicchio/Belgian endive.
FLOWER: Perfect, mostly-self-pollinating flowers. Pollen from C. endivia will pollinate C. intybus (radicchio), however C. endivia will not be pollinated by C. intybus .
HARVEST: A few outside leaves can be harvested for eating without harming seed production. Allow plants to dry completely after most of the flowers have set pods. Pry open pods to release dry, hard seeds.
PROCESS: Small amounts of seed can be left in pods and replanted. Some thinning will be required. Crush large amounts of pods in cloth bag with wooden mallet. Screen and winnow to remove debris.

Onion - Allium sp.
Varieties within each onion species will cross with each other. Crosses between species although not common, are possible.
Allium schoenoprasum: Common chives
Allium tuberosum: Garlic chives
Allium fistulosum: Japanese bunching onions (Occasional crossing between A. fistulosum and A. cepa has been observed.)
Allium cepa comprised of three groups: Aggregatum includes shallots, multiplier onions and potato onions; Cepa our biennial, common storage and slicing onions; Proliferum includes the Egyptian or walking onions.

PLANT: Separate from other flowering Alliums of the same species at least 1000 feet for satisfactory results or at least 1 mile for purity. Caging with introduced pollinators or alternate day caging is also recommended in small gardens. Seed to seed: Plant seeds in late-spring or early-summer. Immature onions are more winter hardy than larger, full-grown bulbs. Mulch in late-fall to ensure winter survival. Thin to 12" spacing in the spring. Root to seed : Harvest in the fall and select the largest bulbs which produce more seed. Clip tops to 6" and store at 35-40° F. in dry, airy location. Replant in early spring with 12" spacing. Cover bulbs with 1/2" soil.
FLOWER: The Alliums produce perfect flowers, most of which are cross-polli nated because stigmas in each flower become receptive only after pollen in that flower is shed. Flowers in an individual umbel open and shed pollen at different times so crosses can and do occur on the same plant. Cross-pollination is performed mostly by bees. Many onions require vernalization (cold, winter-like temperatures for

several weeks) before flowering occurs. Store for at least two weeks in a refrigerator.
INBREEDING DEPRESSION: Onions display a fair amount of inbreeding depression after two or three generations of self-pollination. Save and mix the seeds from at least two different plants.
SELECTION TRAITS: Bulb color: white, D; buff, red, yellow, r.
HARVEST: Clip umbels as soon as majority of flowers have dried. Seeds will start dropping from some flowers at this time so check often. Allow to dry in cool, dry location for up to 2-3 weeks.
PROCESS: Fully dried flowers will drop clean seeds naturally. For small amounts, rub remaining flowers to free seeds. For larger amounts, rub heads over screens. Winnow to remove remaining debris.

Radicchio/Belgian Endive - Cichorium intybus

PLANT: Isolate different varieties by 1/2 mile to ensure purity. Pollen from escarole and
frisee, C. endivia, will contaminate C. intybus and must also be isolated. Wild chicory will cross and should be eliminated. Seed to seed: Mulch in late-fall to insure winter survival. Thin to 18" spacing in the spring. Root to seed: Harvest in the fall and select the best roots. Clip tops to 2" and store at 35-40° F. in humid location for up to 3 months. Replant in early spring with 18" spacing.
FLOWER: Although chicory flowers are perfect, they do not self-pollinate. Insects perform cross-pollination.
HARVEST: A few outside leaves can be harvested for eating without harming seed production. Allow plants to dry completely after most of the flowers have set pods. Pry open pods to release dry, hard seeds.
PROCESS: Radicchio seed is difficult to remove from the pods. The entire pod can be planted without removing the seeds, but some of the numerous seedlings emerging in each location will need to be thinned. Crush large amounts of pods in cloth bag with wooden mallet. Screen and winnow to remove debris.

Turnip/Chinese Cabbage - Brassica campestris
Formerly B. rapa. B. campestris varieties, divided below into five separate groups because of similar features, will cross with each other.)
Rapifera: root turnips

Ruvo: flower-stalk turnips including Italian turnips, rapa and broccoli raab
Chinensis: nonheading varieties of Chinese mustard including pak choi and celery mustard
Pekinensis: heading varieties of Chinese cabbage
Perviridis: spinach mustards

PLANT: Separate B. campestris varieties at least 1000 feet for satisfactory results or at least 1/2 mile for purity. Caging with introduced pollinators or alternate day caging is also recommended in small gardens. Seed to seed : Plants left for seed production should be mulched in the fall. Flowering plants can grow 3' tall and need at least 2' spacing for good seed production. Root to seed: Carefully dig roots in the fall, trim tops to 2" and store for the winter in humid location (layered in sand or sawdust) with temperatures 35-40° F. Replant best roots in early spring with 2' spacing.
FLOWER: The B. campestris species produces perfect flowers, most of which cannot be self-pollinated. Cross-pollination is performed mostly by bees. The stigma becomes receptive before the flower opens. Pollen is shed hours after the flower opens. B. campestris varieties require vernalization (cold, winter-like temperatures for several weeks) before flowering occurs. Store for at least four weeks in a refrigerator.
INBREEDING DEPRESSION: Plant at least 6 different plants to ensure a reasonable amount of genetic diversity.
HARVEST: Turnips grown for seed should not be trimmed for eating. Chinese cabbage can be lightly trimmed for eating without affecting quality seed production. If small amounts of seeds are wanted, allow individual pods to dry to a light brown color before picking and opening by hand. Lower pods dry first followed by those progressively higher on the plant. For larger amounts of seeds pull entire plant after a majority of pods have dried. Green pods rarely produce viable seeds even if allowed to dry after the plant is pulled.
PROCESS: Smash unopened pods in a cloth bag with mallet or by walking on them. Chaff can be winnowed.