Saving Seed

by Dr. Theodore Radovich

Farmers and gardeners have saved their own fruit and vegetable seed for millennia. Saving seed from desirable plants is a fundamental act of agriculture and has resulted in thousands of fruit and vegetable varieties we have today. Seed saving takes time and other resources away from growing crops, and most commercial farmers prefer to purchase seed from companies that specialize in producing it. Still, many farmers and gardeners will save at least some of their own seed to select and preserve well adapted varieties that may not be available in the commercial market. Several vegetable varieties selected and saved by Hawaii farmers are available from the University of Hawaii Seed Program. This article highlights key points to be aware of when saving seed. For more details regarding seed saving please see the resources at the end of this article.

Figure 1. Organic seed production at the CTAHR Waimanālo Research Station. Foreground: 'Kewalo' tomato and 'Koba' green onion. Background: 'Hirayama' mustard

Let's talk about sex, baby.

Understanding the basic reproductive biology of plants is an important part of seed saving. The majority of plants outcross, which means that pollen from different flower(s) germinate on the stigma of the mother flower, travel down the style and fertilize the ovules. Outcrossing increases genetic diversity of the population, which increases the potential for adaption of the variety to future changes in environment. Many vegetable crops naturally outcross, including sweet corn, pumpkins, and eggplant. Different mechanisms have evolved to maximize the chance of outcrossing in vegetables. For example, male and female parts may be on separate flowers as they are in corn and cucumber (Fig 2), or even on separate plants (as in male and female papaya). In flowers with male and female parts, pollen shed may occur before or after the stigma is receptive or the style may be protrude beyond the anthers, increasing the potential for insect-mediated cross-pollination.

When saving seed from an open-pollinated variety there are several important things to keep in mind:

- Remove (rogue) off-types from the population.
- Isolate varieties of the same crop from each other. Isolation can be done in distance (660 feet for corn), in time (plant varieties so they flower at different times) or by bagging flowers (Fig 3).
- Save seed from as many individuals as possible. Minimum individuals recommended for most open-pollinated species is 80, although seed from as many as 200 individuals is recommended for corn to minimize inbreeding depression.

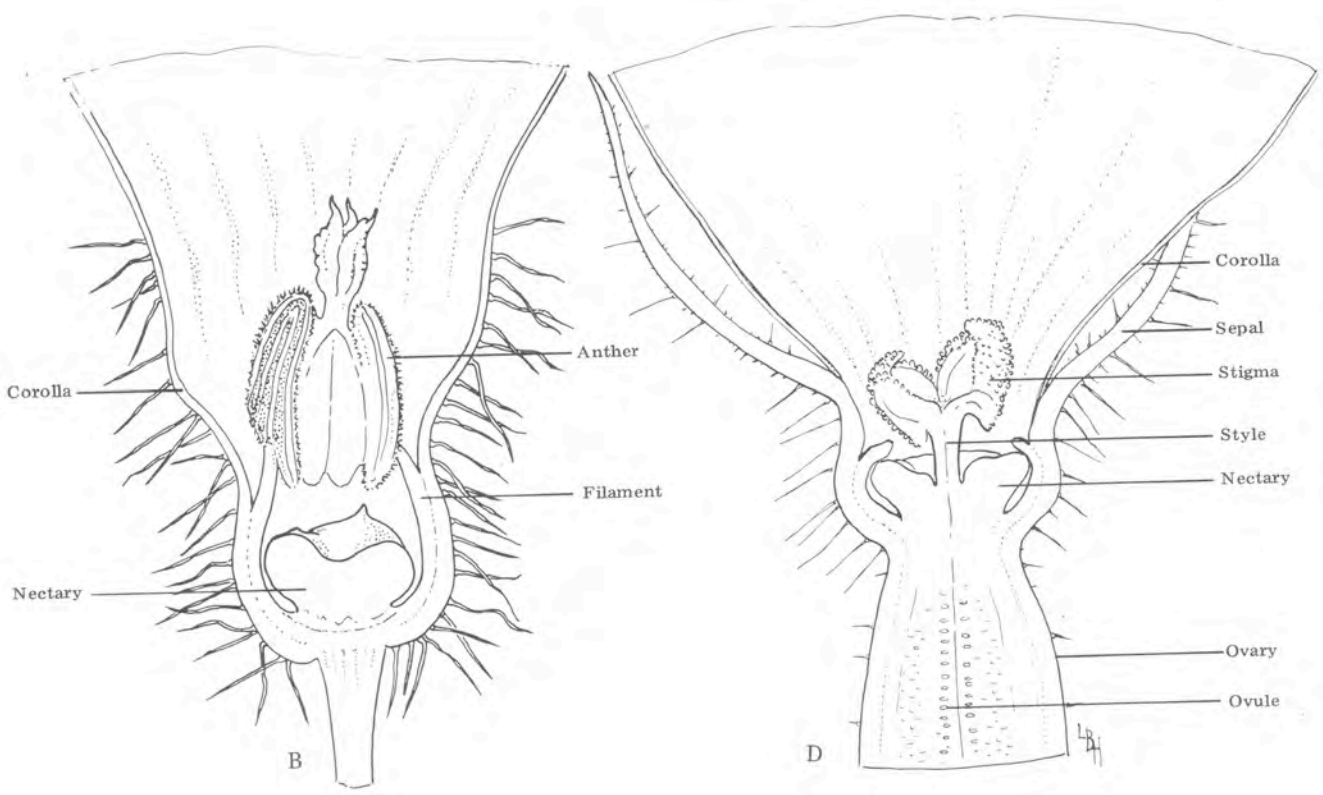

Figure 2. Longitudinal sections of cucumber flowers: Left) Male flower; Right) Female flower. From: ARS (1976).

Self pollinated species include peas, beans and lettuce. Most tomato varieties are also self-pollinating. The anthers on the flowers of self pollinated crops typically surround the pistil, and pollen shed often occurs before flowers open, ensuring self pollination. Isolation in self pollinated varieties is less of a concern than in open pollinated varieties, but outcrossing can still occur especially if plants are touching or pollinator populations are high and diverse in species. Recommended distances between self pollinated varieties of the same species are 10-15 feet. Seed should be saved from at least 15-50 individuals in self pollinating populations.

Hybridization refers to the controlled cross between individuals from two distinct varieties. Reasons for hybridization include hybrid vigor (increased yield), disease resistance and variety protection. Many commercial varieties are hybrids. Seed saved from hybrid vegetables may not germinate, or if so, will likely not produce uniform populations of individuals resembling the parent plants. For those interested in making their own hybrids and developing their own cultivars, see the reference by Allard (1999) and Deppe (2000).

Figure 3: Bagged papaya flowers

Special needs

Special considerations need to be made when growing plants for seed. Planting should be timed so that seed maturation occurs during dry weather, if possible. Plants will be in the field much longer when grown for seed than for food (e.g. 30 days vs. 120 days in lettuce). Spacing of seed crops should be wider than when grown for food to accommodate larger plant size and maximize airflow to reduce chance for disease.

Seed harvesting & cleaning

Seed should be allowed to mature as fully as possible on the plant, but mature seed should be harvested as soon as possible to avoid losses to birds, rain and disease.

In the case of dry seed like lettuce and beans, plants may be cut from the field when mostly dry and allowed to complete drying on benches in a well ventilated, covered structure like a green house, garage or barn. Seed matures sequentially (bottom up) on inflorescence, so some growers will walk through a field periodically and shake the inflorescence into a bucket or garbage can to collect the older most mature seed, and allow the rest to remain on the plant. Growers may also place woven weed mat around the base of plants to collect dropped seed. Once dried, the seed will need to be cleaned of its protective material. For small scale cleaning of dry seeds, an effective method is to simply put the seed heads in a cloth bag or pillow case and physically "stomp and grind" the dried inflorescence through the bag with your feet or hands to loosen the seed from the other material. Wind or fans may then be used to blow the lighter chaff away from the seed. Gently tossing the processed material up in the air using a shallow pan or basket outdoors with a strong breeze is a common strategy to do this.

Seed processing from fleshy fruits requires slightly different steps than dry fruits. Although tomatoes harvested for seed may be picked at the same maturity stage as used for eating, other fruits like cucumber and eggplant must be left on the plant for much longer than usual to ensure maturity when saving seed. If harvested too soon, seeds from immature fruit will not germinate or germinate poorly. Seed scooped out of fleshy fruits are best processed by fermenting in water to remove closely associated material and germination inhibitors. The most common process for small scale producers is to soak the seed in an excess of water for 2-3 days, stirring twice daily. In some cases (e.g. papaya) fairly intense agitation with a blender and rubber blade may be used (for more information, see Producing Organic Papaya Seed at YouTube). For larger seed cleaning operations, commercial enzymes are available to speed up the fermentation process. After the fermentation step, seeds are drained, rinsed, and dried on paper towels or screen. Seeds may then be air-dried, or a fan on low speed can be used. The details of seed processing varies with species. See the references section for more details.

Storage

Most growers are content to store seed from year to year, or for a few years at most. These growers follow the "Rule of 100." The Rule of 100 states that the sum of temperature (F) and Relative Humidity equal 100. For example, refrigeration at 50 F @ 50% relative humidity fit these criteria. Seed dried to 2-5% and stored in the refrigerator in an airtight container can maintain viability for decades. Ex-

ceptions to this rule include very large seeded species (e.g. avocado and mountain apple) and are called "recalcitrant." Most vegetable species follow the Rule of 100, and are thus called "Orthodox." For more details regarding seed saving, especially long term storage and "seed-banking", see Yoshinaga (2010), and cited references therein.

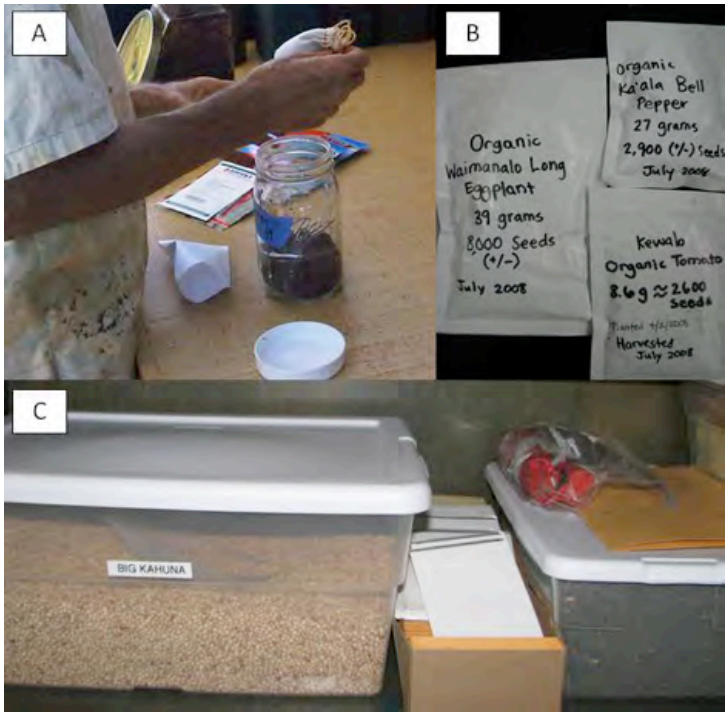

Figure 5. Seed may be stored for several years in glass jars (A), self sealing foil-lined packets (B) or sealable plastic containers (C).

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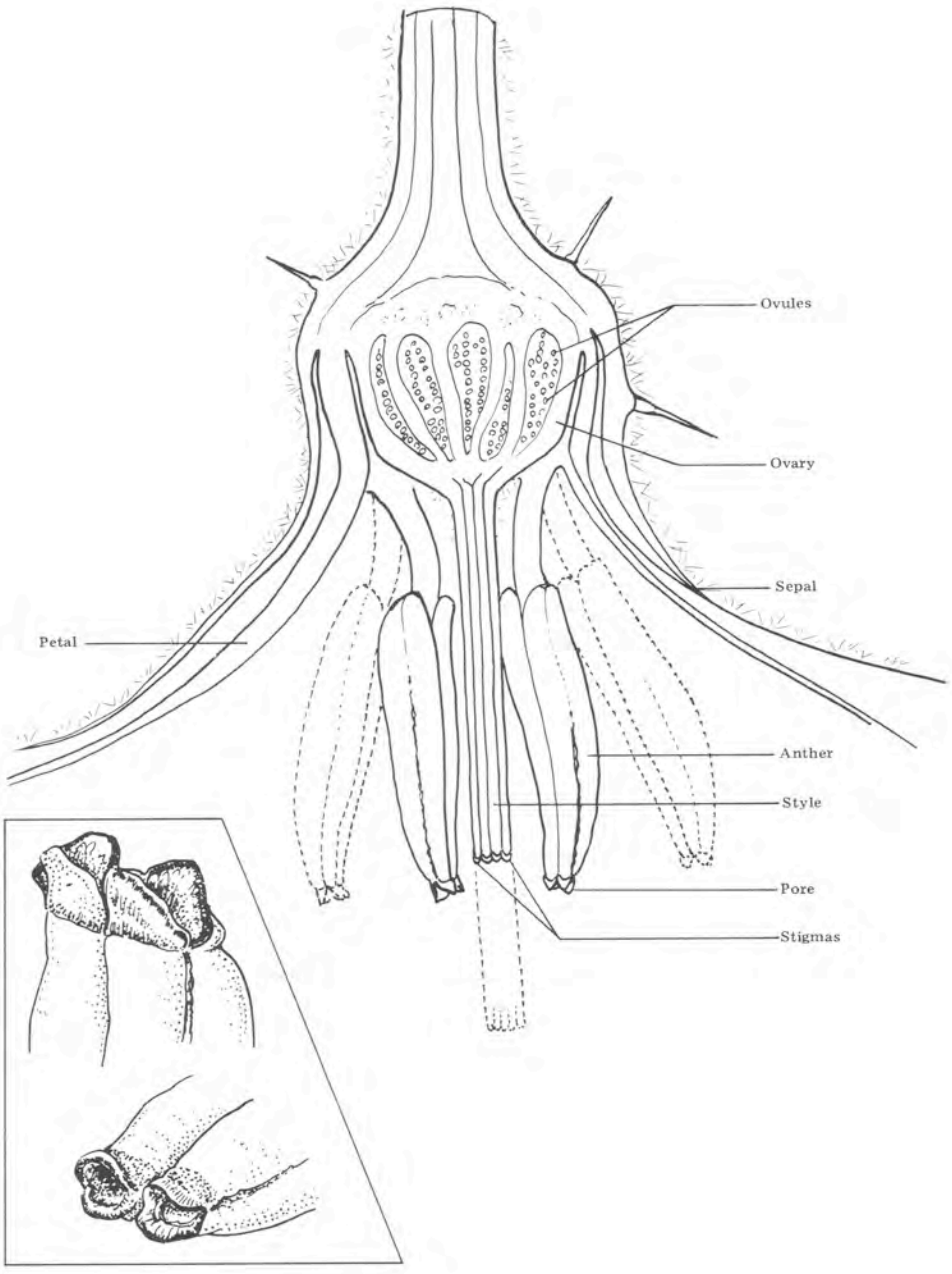

Figure 2. Longitudinal section of eggplant flower. Dotted areas indicate variation in length of style and position of stamens. Inset shows pores of anther tubes enlarged. From: ARS (1976).

Table 1. Definitions of select terms relating to vegetable reproductive biology (from Radovich, 2011.)

Term	Definition
Andromonecious	Male and perfect flowers on same plant.
Annual	Plant that completes life cycle (sets seed) and dies in one year.
Berry	Fruit fleshy throughout.
Biennial	Plant that completes life cycle (sets seed) and dies in two years.
Bolt	Develop inflorescence prematurely, as in lettuce and spinach.
Bract	Modified leaf or scale at base of flower.
Calyx	Sepals or outer whorl of perinanth.
Carpel	Individual unit of compound pistil.
Caryopsis	Fruit (grain) of grass, as in sweet corn.
Cultivar	Group of cultivated plants with distinguishing characteristics that are retained when plants are reproduced.
Determinant	Branch stops growing at flowering.
Dioecious	Staminate and pistillate (female) flowers on separate plants.
Endocarp	Inner layer of fleshy fruit wall.
Floret	Small flower on inflorescence, e.g. broccoli.
Fruit	Mature ovary.
Gynoecious	Producing predominantly, or only, female flowers.
Indeterminant	Branch continues to grow after flowering starts.
Legume	Single carpel fruit with two sutures, seed attached along one suture. Characteristic fruit of the bean family.
Lenticel	Raised dot or pore for gas exchange.
Locule	Seed cavity of fruit. Also compartment of ovary or anther.
Monoecious	Male and female flowers on same plant.
Pedicel	Stalk or stem of individual flower or floret
Peduncle	Primary flower stalk of inflorescence.
Pepo	Cucurbit fruit, leathery or woody exocarp inseparable from endocarp.
Perfect flower	Flower with both male and female parts.
Pericarp	Fruit wall.
Perennial	Plants persisting for three years or more.
Scales	Fleshy or dry modified leaves of a bulb.
Sillique	Specialized fruit of the cabbage family, with two fused carpels.