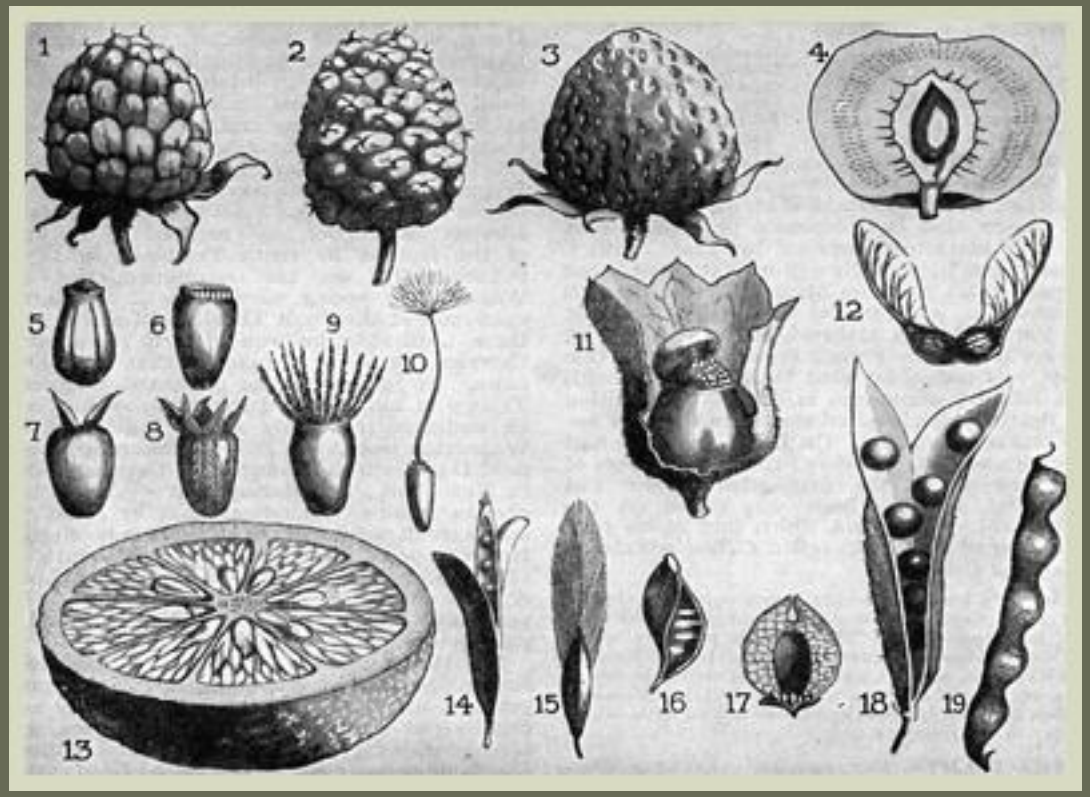
SEED SAVING



To see things in the seed, that is genius.

Lao Tzu

INTRODUCTIONS

(one minute per person)

1. Name
2. Occupation
3. Foodshed: your ecological/agricultural region
4. Your history of saving seed
5. What is your goal for this training.

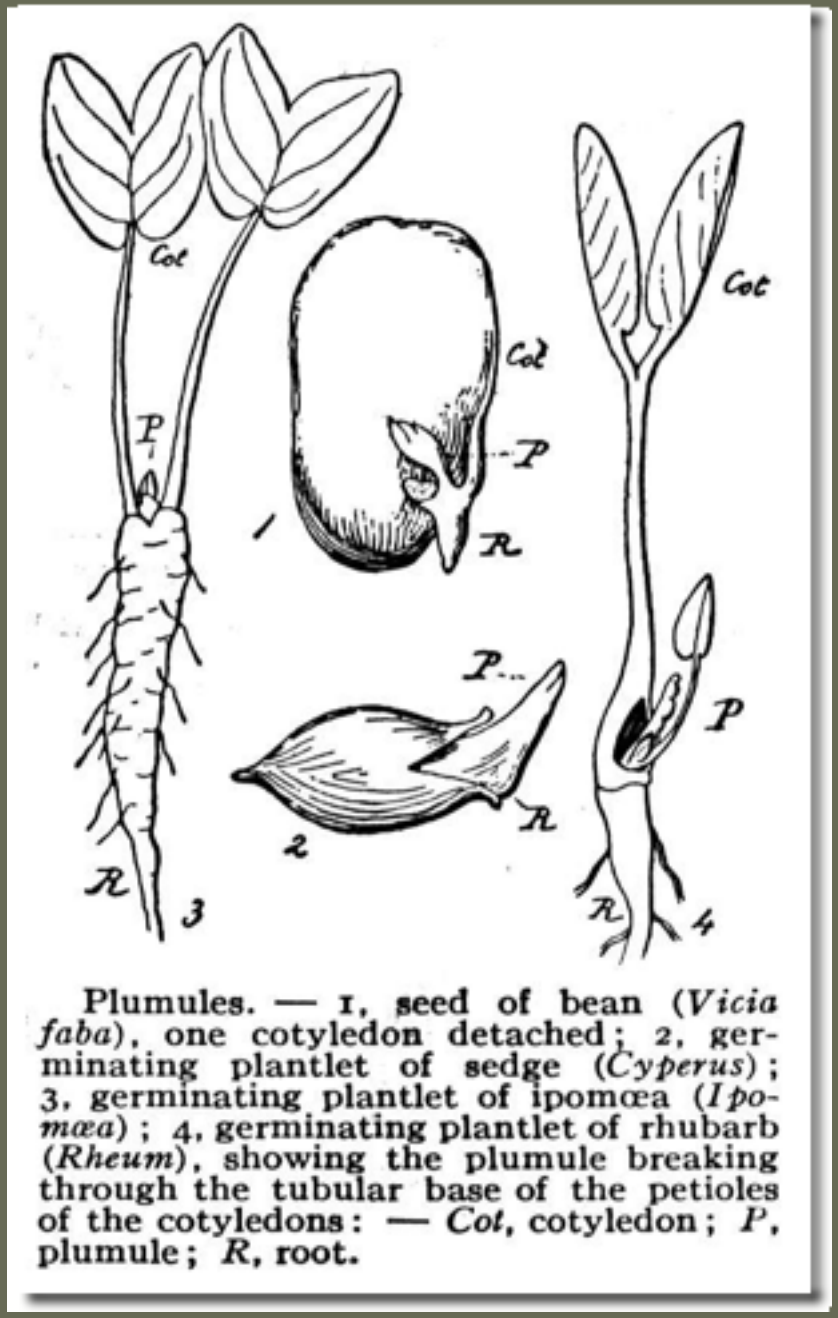
Our goal: To increase the conservation and spread of ecologically grown, bio-diverse and regionally adapted seed

FUNDAMENTAL IDEAS:

- Sustainable food systems rely on sustainable seed systems.
- Seed is a natural resource that should be available to all.
- Seed saving is a skill that should be learned and shared.
- Continued practice of seed saving by individuals can contribute to community, regional, national, and international seed security.

4 questions to ask before you begin growing seed

1. Why am I saving seed?
2. What seed is best for me?
3. What biological principles are fundamental to seed saving?
4. What skills and techniques are needed to save seed?



Plumules. — 1, seed of bean (*Vicia faba*), one cotyledon detached; 2, germinating plantlet of sedge (*Cyperus*); 3, germinating plantlet of ipomœa (*Ipomœa*); 4, germinating plantlet of rhubarb (*Rheum*), showing the plumule breaking through the tubular base of the petioles of the cotyledons: — *Cot*, cotyledon; *P*, plumule; *R*, root.

6 learning modules will help answer these questions:

1. Why save seed.
2. What seed is best for me.
3. Biological principles: Plant taxonomy.
4. Underlying biological concepts.
5. Skills and techniques for saving seed.
6. Review: final reflections on the 4 seed saving questions.

1. WHY SAVE SEED?

A. WHY SAVE SEED?

As a member of a community, nation and planet.

Why is saving seed important for maintaining a sustainable food system?

B. WHY SAVE SEED?

As an individual.

On what level am I interested in saving seed?

a. To just play around in my garden, maybe seed swap.
b. To adapt a variety to your climatic conditions and insure a source of resilient seed.
c. To preserve the genetics of a variety (an heirloom perhaps) and insure a reliable source.
d. To contract with seed companies to produce seed as a source of income.
e. Other?

2. WHAT SEED IS BEST FOR ME

Seed Choices:

Open Pollinated (OP) – OP's produce seed that closely resemble the parent. OP varieties are a result of combining parents that are genetically similar. If you plant an OP, save seed and grow that seed the next season, the plants will look like the ones you grew last year.

Heirloom – Non-hybrid/open-pollinated varieties that have been passed down from generation to generation (>50 years old is generally considered an heirloom).

Hybrid (F1) – F1's are a result of a controlled crossing of inbred, genetically distinct parent populations. Seed saved from F1's will appear very different from their parents, only a few plants will look like the original F1 variety.

GMO Varieties - Varieties in which genes have been inserted into the DNA of the host variety. The genes that are transferred are often from different species, genera, or even kingdoms (e.g. Bt toxin).

Seed Choices

From Annuals – Plants that require only one growing season to produce seed and complete their life cycle.

From Biennials – Plants that require two growing seasons to produce seed and complete their life cycle.

From Perennials – Plants that live more than two years, usually producing flowers and seeds from the same root year after year.

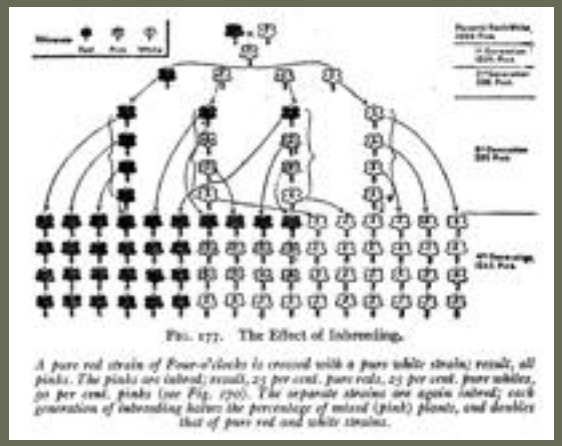
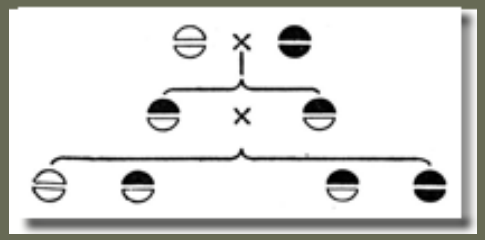
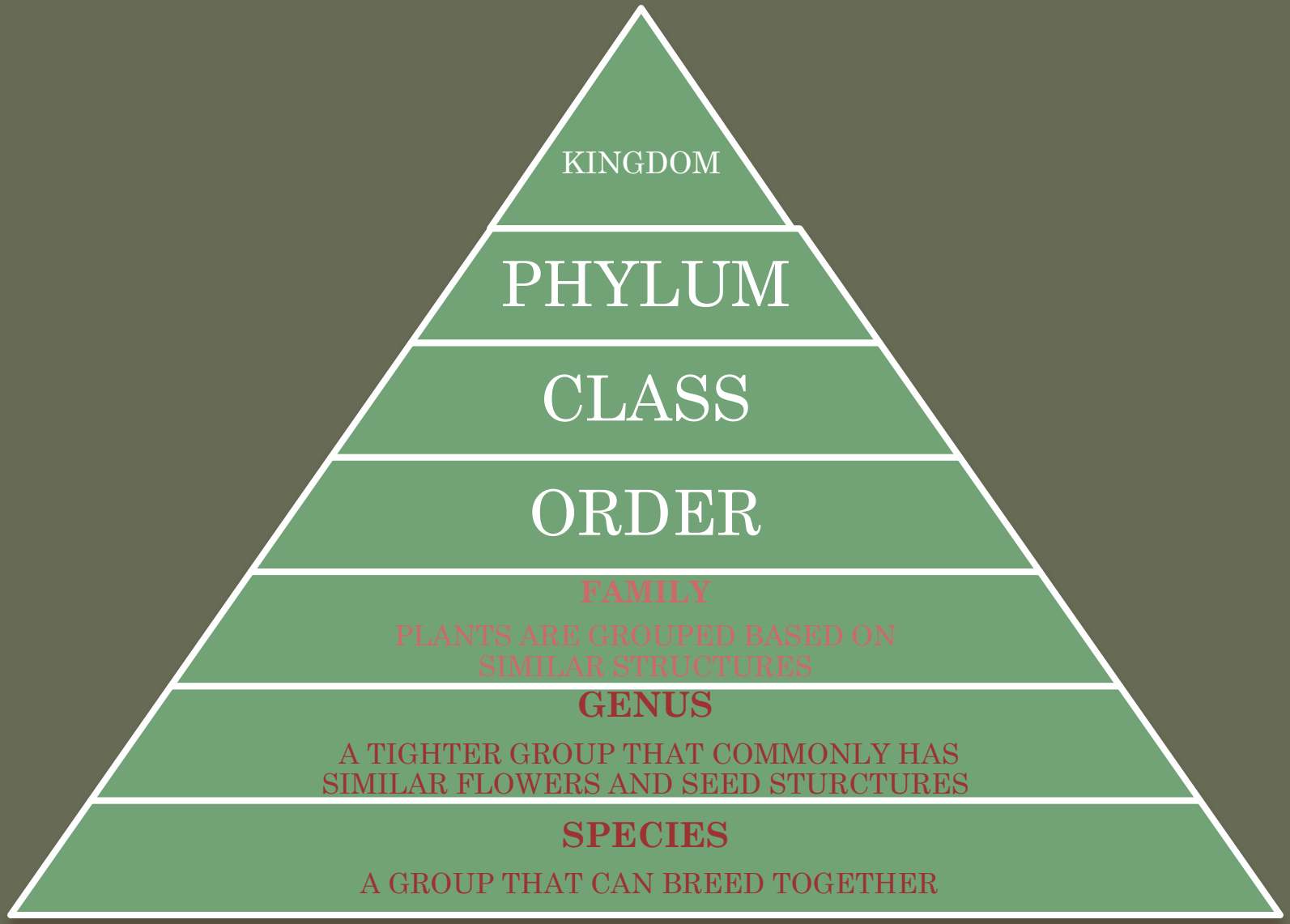


FIG. 177. The Effect of Inbreeding.

A pure red strain of Four-o'clocks is crossed with a pure white strain; result, all pinks. The pinks are inbred; result, 25 per cent. pure reds, 25 per cent. pure whites, 50 per cent. pinks (see Fig. 176). The separate strains are again inbred; each generation of inbreeding halves the percentage of mixed (pink) plants, and doubles that of pure red and white strains.



3. UNDERLYING BIOLOGICAL PRINCIPLES: PLANT TAXONOMY



Taxonomy is a system of arranging plants into related groups based on common characteristics.

What's in a name?

The flowers of peppers primarily self pollinating, but insect cross pollination is common.

BOTH the cayenne pepper variety and the jalapeno pepper variety pictured to the right belong to:
Genus: *Capsicum*
Species: *Capsicum annuum*

What advice would you give this seed saver for maintaining the genetic purity of each variety if they want to grow both in the same greenhouse?

Knowing the family of your plants will help you generalize the seed saving techniques from one member of the family to other members of that same family. For example:

Family – CUCURBITACEAE

This family contains squash, melons, cucumbers and gourds. Members of the same species will accept pollen from other crops and varieties within the species. Isolation to control crossing within the species is critical with diverse crops such as squash.

Family – CUCURBITACEAE

Genus – Cucurbita

Species – Cucurbita pepo

Variety – Black Beauty zucchini

Variety – Yellow Crookneck squash

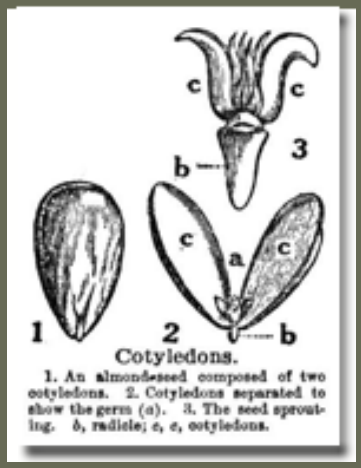
Variety – Connecticut Field pumpkin

Variety – Patty Pan scallop

Variety – Spaghetti squash

Anthers.

a, anther; *b*, pollen; *c*, filament.



Cotyledons.

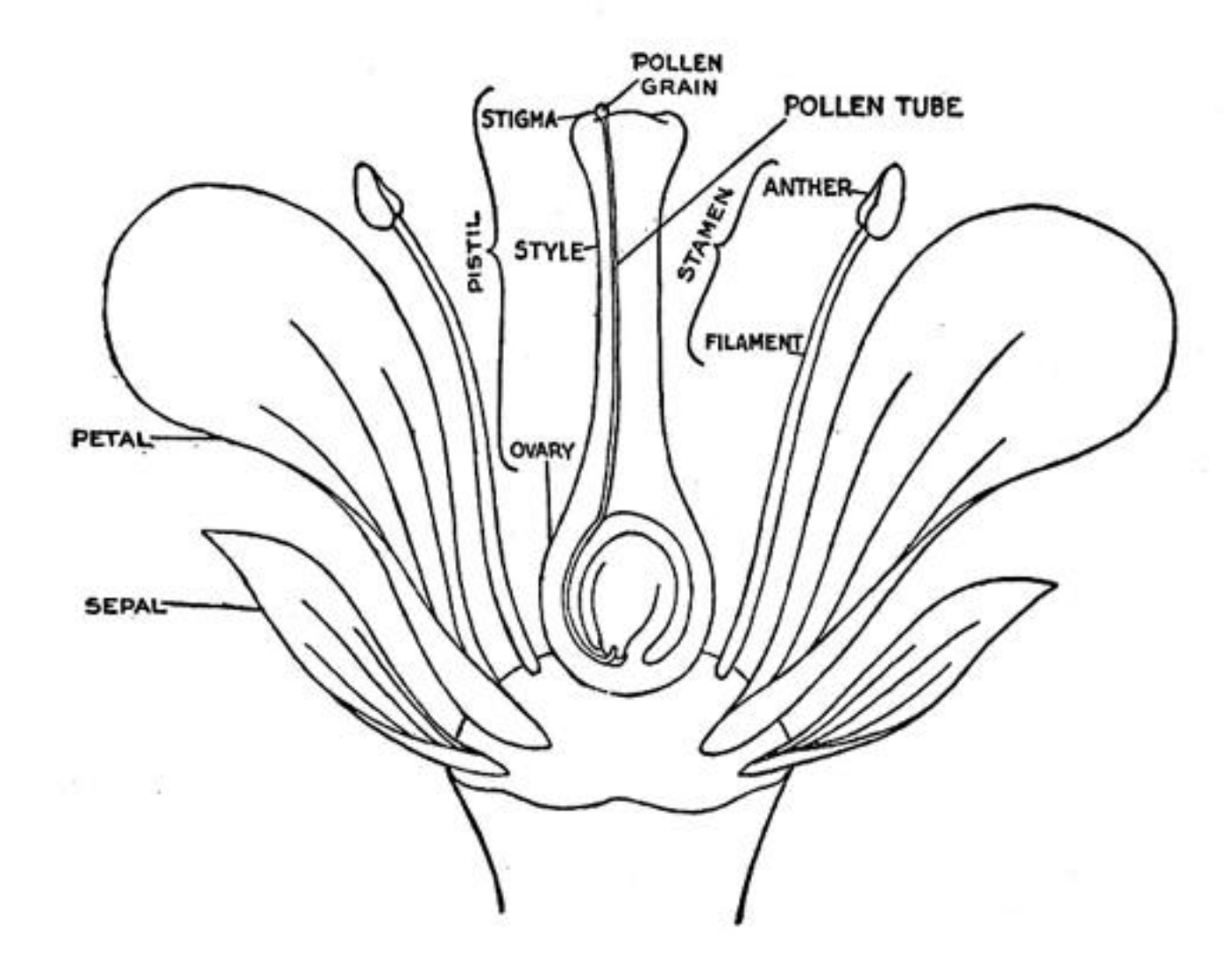
1. An almond-seed composed of two cotyledons. 2. Cotyledons separated to show the germ (*a*). 3. The seed sprouting. *b*, radicle; *c*, *c*, cotyledons.

4. UNDERLYING BIOLOGICAL CONCEPTS: REPRODUCTION

4. Underlining Biological Concepts - Reproduction basics:

A. Flower anatomy: structure and function.
B. The “Mating System” of your plant…how it pollinates.
C. Techniques that improve or maintain seed physical and genetic qualities.

A. Flower anatomy

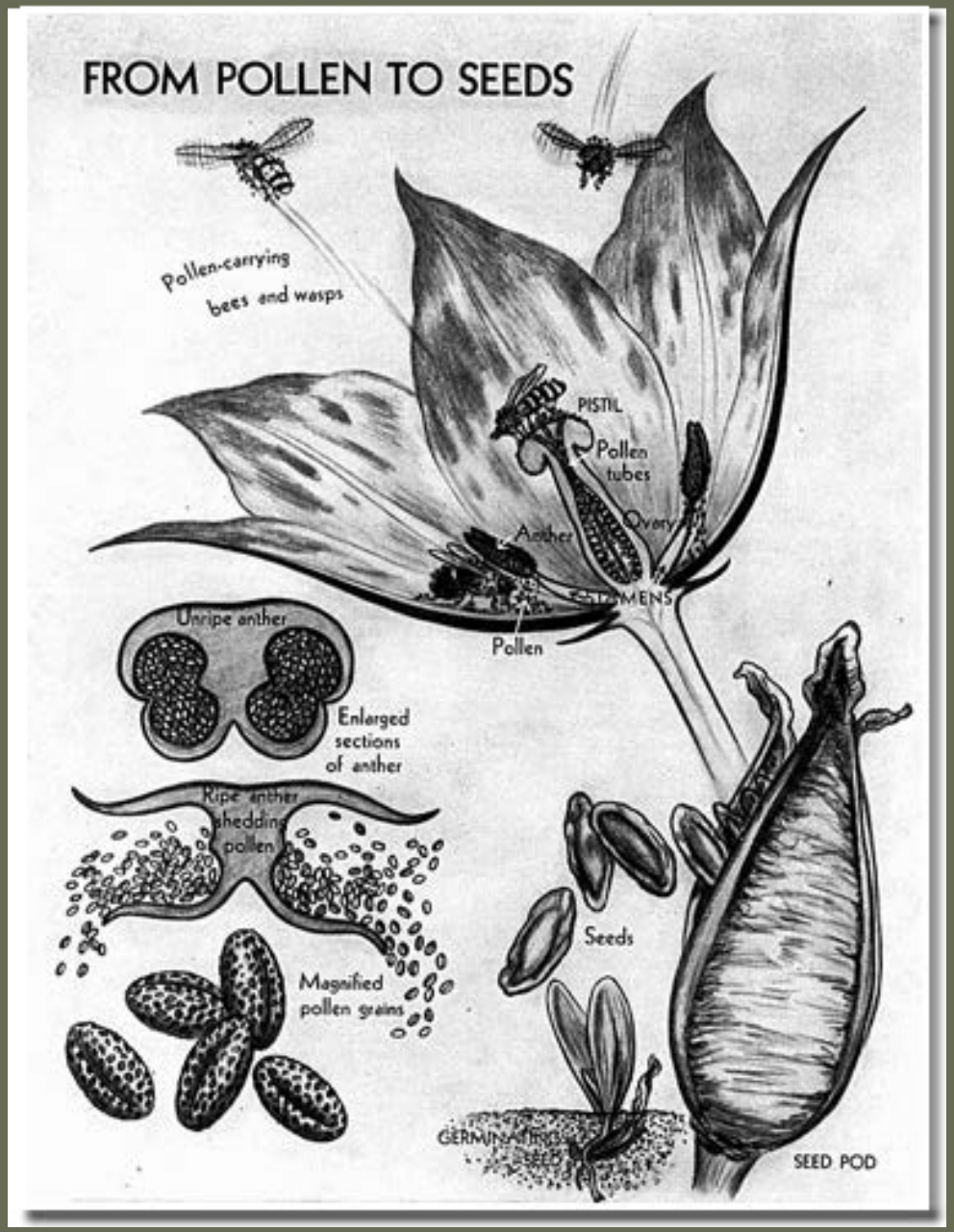


A flower is the reproductive organs of a plant wrapped in sepals and petals.

Flower function:

Pollination: Pollen produced from the stamen must land on the surface of the stigma.

Fertilization: Once it has landed on the stigma, pollen must germinate and grow a pollen tube down through the style to the ovary and fertilize the ovule. Each fertilized ovule becomes a seed.


FROM POLLEN TO SEEDS
Pollen-carrying bees and wasps
PISTIL
Pollen tubes
Ovary
Anther
STAMENS
Pollen
Unripe anther
Enlarged sections of anther
Ripe anther shedding pollen
Magnified pollen grains
Seeds
SEED POD

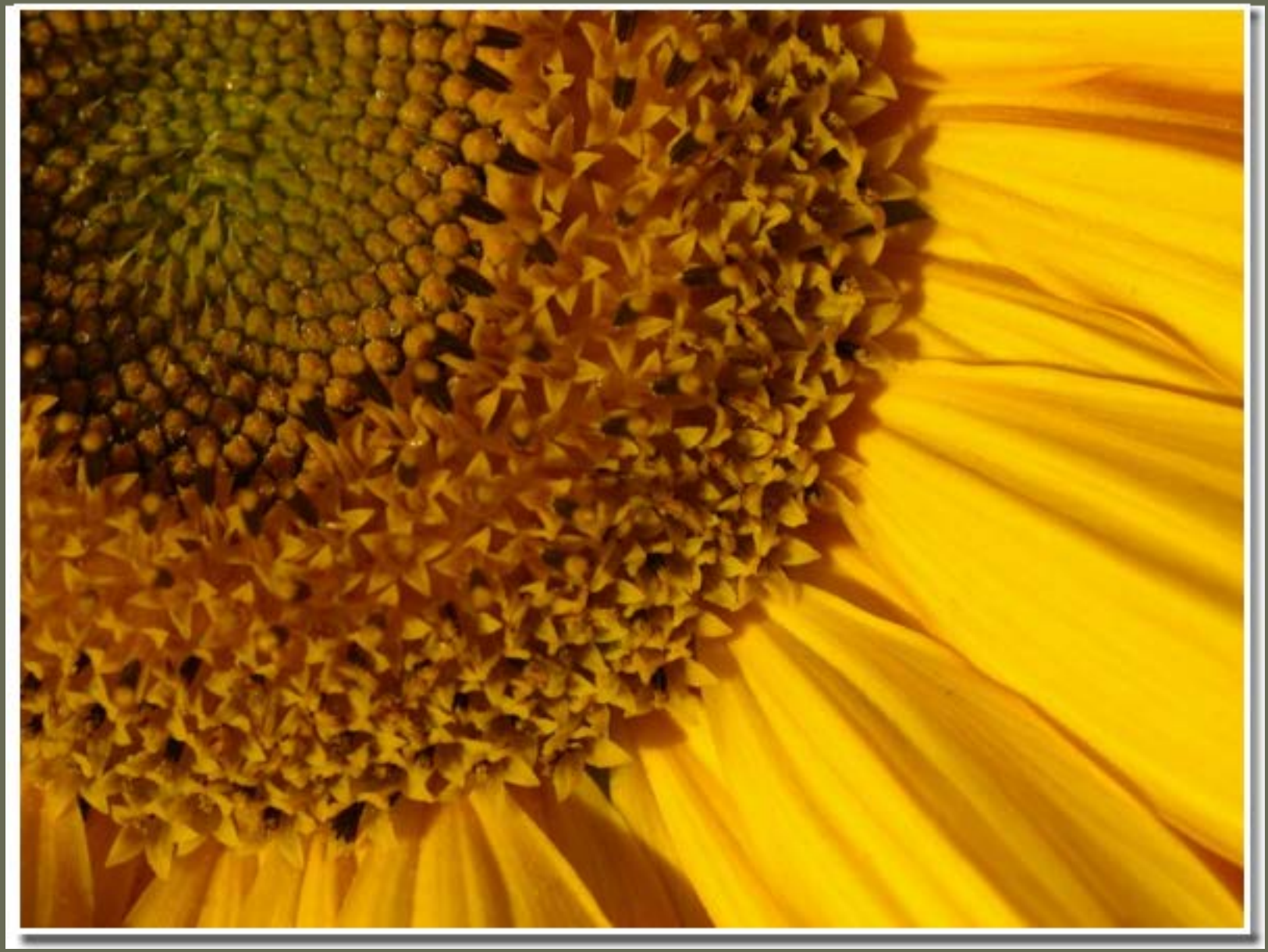
B. The "Mating System" of your plant:

1. **Bisexual "perfect" flowers** contain **BOTH** the male and the female reproductive organs.

2. **Unisexual "imperfect" flowers** contain **EITHER** the male organs **OR** the female organs…not both. If plants have "unisexual" flowers, they either:
   - Have male and female flowers on the same plant – **monecious** (one house)
   - Have male and female flowers on separate plants – **dioecious** (two houses)

PERFECT FLOWERS

- Perfect flowers contain both male and female parts in one flower.
- Tomato, Bean, Pea, Broccoli, Cabbage, Carrot, Sunflower, Lettuce



IMPERFECT FLOWERS

Female ear

Male tassel

Imperfect flowers are either male or female. The female flowers contain the ovary and pistil and can make fruit. The male flowers contains the stamen that makes pollen and cannot make fruit.

Corn, Squash, Cucumbers, Watermelons, Walnuts

IMPERFECT FLOWERS CAN BE ON SEPARATE PLANTS: DIOECIOUS

Female spinach plants

Male spinach plants

IMPERFECT FLOWERS CAN BE ON THE SAME PLANT: MONECIOUS

Female squash flower

Male squash flower

Inside female flower
Hubbard squash viewing stigma

Inside male flower
Hubbard squash viewing anther

Inbreeding plants are self fertilizing, or self-pollinating, and essentially mate with themselves. The pollen of one flower on the plant fertilizes the ovule of the same flower. The offspring are therefore very similar to the parent.

Outbreeding plants will cross pollinate and mate with another plant of the same species. The pollen of one plant fertilizes the ovule of another plant of the same species. This mixing produces offspring that can be genetically different from the parent.

Most species will both self and cross pollinate to varying degrees. A plants mating system falls on a spectrum between very inbreeding and very outbreeding.

"very inbreeding"  "very outbreeding"

Inbreeders

- In order of inbreeding tendency: Peas, lettuce, endive, escarole, tomatoes, common beans.
- Self pollination is the norm, but they can cross.
- The spectrum of inbreeding can run from

Very Inbreeding VI ⟷ Primarily Inbreeding PI

Pea flower

Tomato flower

INSIDE A PRIMARILY INBREEDING TOMATO FLOWER

Outbreeders

- In order of outbreeding tendency: Corn, beets, spinach, Brassicas, carrots, celery, cucumbers, onions, melons, squash.
- The dioecious plants have to outbreed…something has to carry pollen from one plant to another.
- The spectrum of outbreeding can run from
- Very Outbreeding VO ⟷ Primarily Outbreeding PO

Spinach flower

Onion flower

MATING SYSTEMS ON A SPECTRUM

INBREEDERS

OUTBREEDERS

RECOMMENDED ISOLATION DISTANCES

3 m	6m	150m	500m	1.5-3 km
5-10ft	20ft	500ft	1600ft	3200ft	1-2 miles

Peas Lettuce Tomato Pepper Squash Brassicas Umbels Amaranths Corn

RECOMMENDED POPULATION SIZE

5 plant population acceptable	12 plant population minimum	60 plants population minimum	200 + plant population recommended

C. Maintaining and Improving Seed Physical and Genetic Quality: POPULATION

Having an adequate gene pool for your crop is essential in retaining the genetic diversity necessary to maintain or improve all the traits you are seeking in your crop including flavor, vigor, resistance, tolerance of drought or saturated soil.

An adequate population size is also necessary to avoid inbreeding depression, particularly in out-breeding crops.

C. Maintaining and Improving Seed Physical and Genetic Quality: ISOLATION

- You can isolate with distance, physical barriers or time.

- If you have a plant that is outbreeding, you must identify any other crops of the same species that can cross with your plant and contaminate your crop with unwanted pollen.

- If there are species (domestic or wild) that can cross with your crop, you MUST provide isolation in order to maintain the trueness of type of your variety.

ISOLATION WITH PHYSICAL BARRIERS

- Here carrot plants are isolated with tenting.
- Other physical barriers might be bags, cages, thick vegetation and or buildings.

ISOLATION DISTANCES

Very Inbreeding (Pea, Lettuce, Endive, Modern Tomato)	**5-20 ft (1.5-6 m)**
Primarily Inbreeding (Lima Bean, Heirloom Tomato, Sweet Pepper)	**640 ft (195 m)**
Inbreeding with some Insect Pollination (Hot Peppers, Runner Bean, Fava Bean)	**3000 ft (900m)**
Insect Pollinated (Carrot, Cabbage, Squash, Eggplant)	**1 mile (1.6 km)**
Wind Pollinated (Beet, Corn, Spinach)	**2 miles (3 km)**

C. Techniques to support reproductive success and maintain your crop's genetics: ROGUING

Roguing is removing the inferior or underperforming plants in your seed crop. Roguing can be done to eliminate: early bolting, slow to germinate, lack of vigor, size, color, disease or any other undesirable trait.

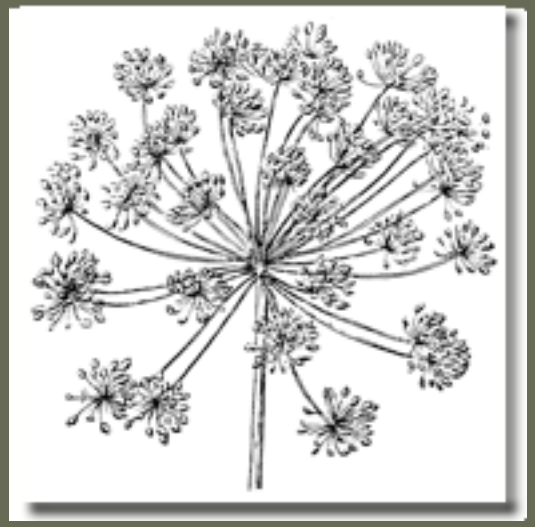
Walking through your crop and pulling plants that you don't want to reproduce will eliminate or minimize their contribution of genes to the next generation of seed accidental crossing.

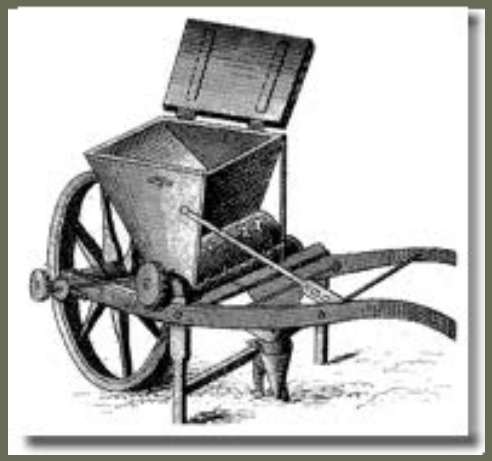
- Rogue more than once during the season.
- Rogue before flowering to remove unwanted pollen.

C. Maintaining and Improving Seed Physical and Genetic Quality: FEED THE SEED

The needs of a seed crop can differ from those of vegetable crops. You will need to:

- Balance the available nitrogen.
- Provide an adequate source of phosphorous.
- Provide spacing needs for crops that become larger as they mature into the seed production.
- Some crops might require staking or trellising to keep them from falling over as they mature and dry.
- Monitor your seed at all stages for disease and weeds.

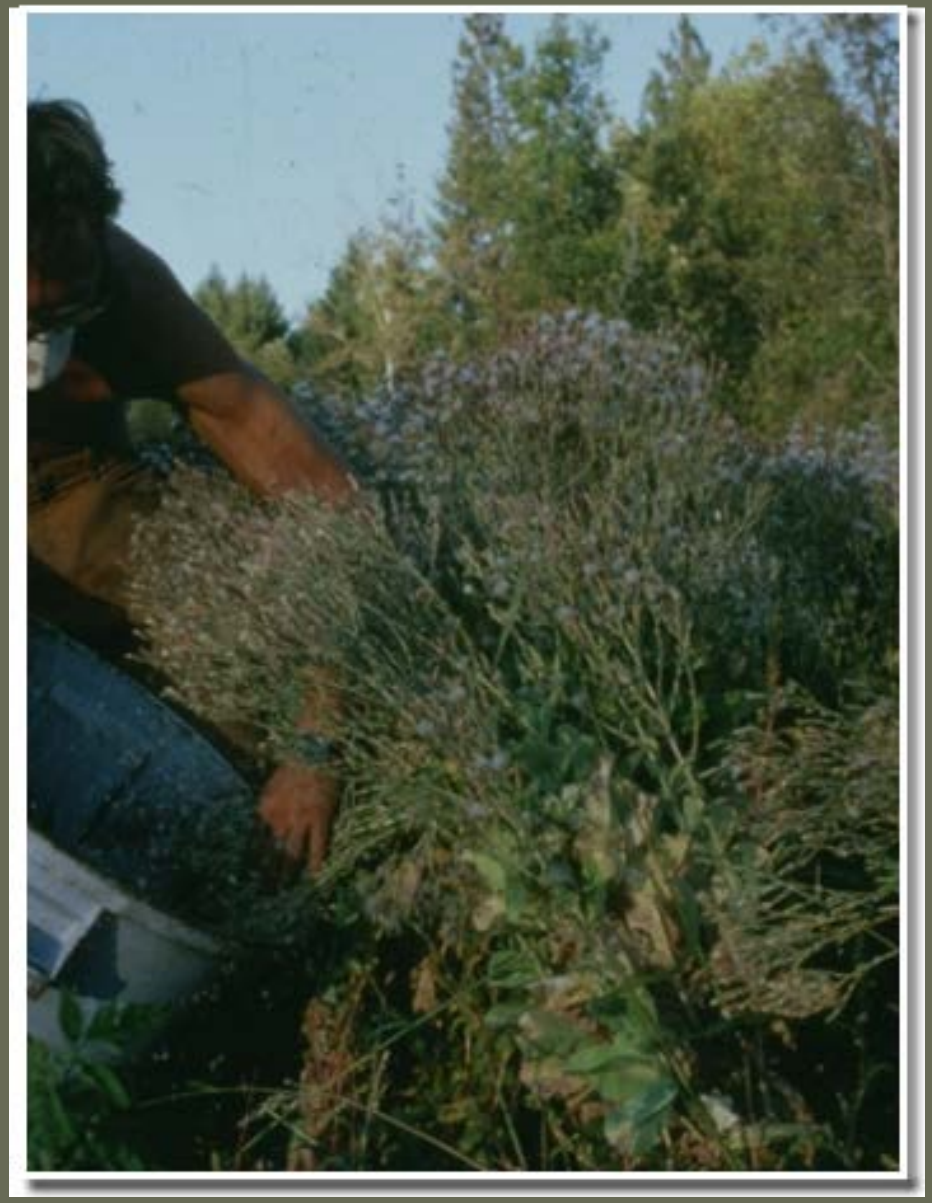




5. SKILLS AND TECHNIQUES FOR SEED SAVING

A. Harvesting and seed cleaning
B. Storing seed

5a. HARVESTING and CLEANING TECHNIQUES



Harvesting techniques:

DRY SEEDED

- Pick by hand
- Shake into bags or buckets
- Pull up the plant and hang
- Cut the plant and hang
- Lay the plants in windrows
- Lay a tarp below the plant and shake or hit the plant to release seed.

Harvesting techniques:

WET SEEDED

- In general let your wet seeded crop mature on the vine as long as possible before harvesting.
- The seeds will continue to increase in size and quality for days to weeks after the first fruit is edible.

Harvesting techniques:

BIENNIAL ROOT CROPS

1. Require two years with vernalization
2. First year is vegetative, no flower/seed formed
3. Selected plants must overwinter in ground or in cold storage.
4. Growth in second year produces flowers/seed
5. Harvest using dry seed techniques.

PARSNIPS AS AN EXAMPLE OF A BIENNIAL ROOT CROP

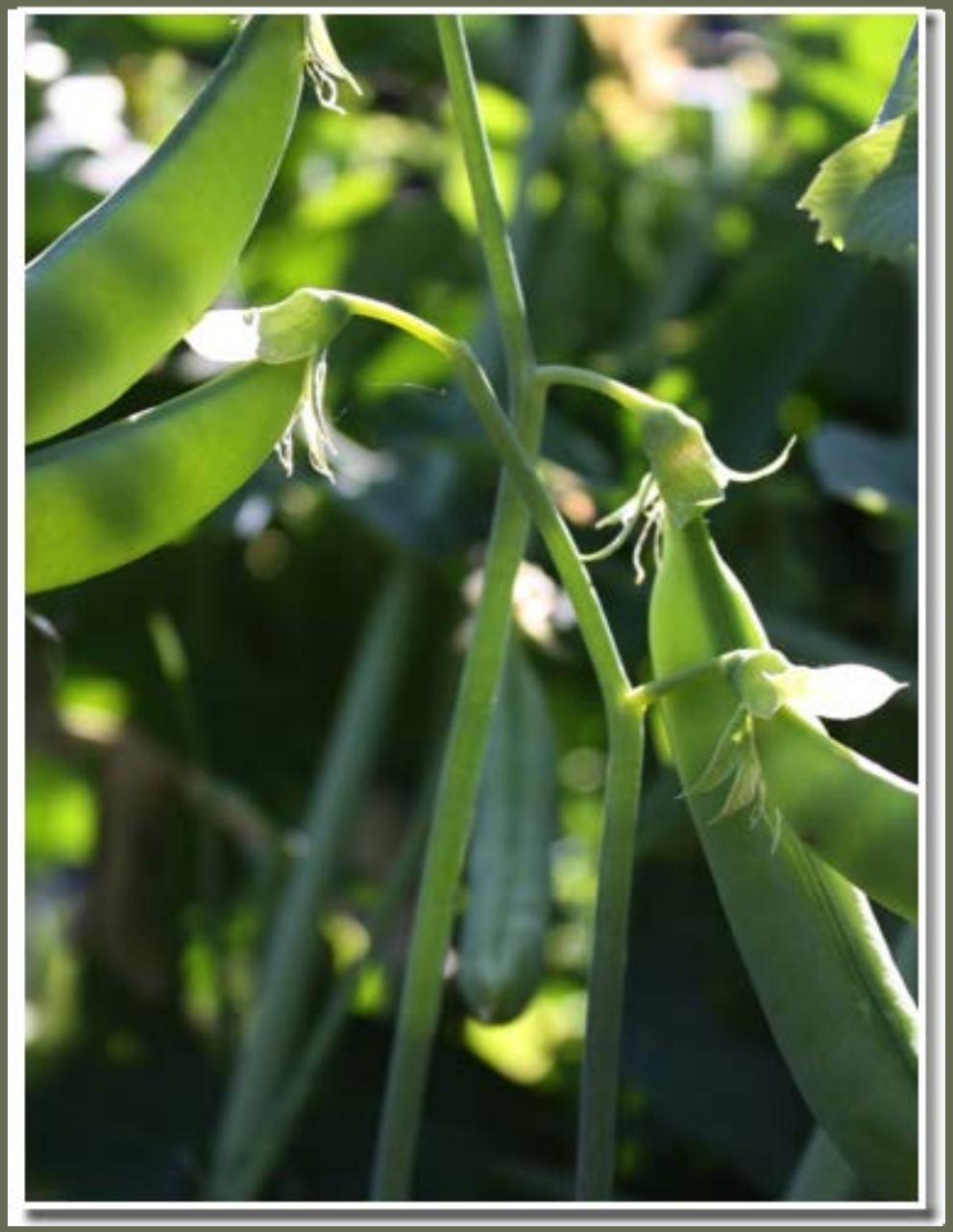
Parsnips allowed to winter over in the ground are dug up

Roots selected for quality: selected roots on the left, discarded roots on the right.

Replant in a block that allows adequate room for maturing and close proximity to encourage pollination

Planted so crown is above soil

Parsnip going to seed in second year



TIMING OF THE HARVEST

- Select a plant that can complete a full life cycle within your growing season.
- Plant early enough to allow full maturity.
- Allow the plant to mature before harvest.
- Harvest at the optimum seed set.
- Either harvest full plant and lay in windrows or select mature seed heads and repeat collections as seed continues to mature.

TIMING OF THE HARVEST

- Timing of the harvest varies for each crop.
- For example, the seed quality and percent germination of many types of winter squash will increase if the seed is left in the fruit for two to three months.

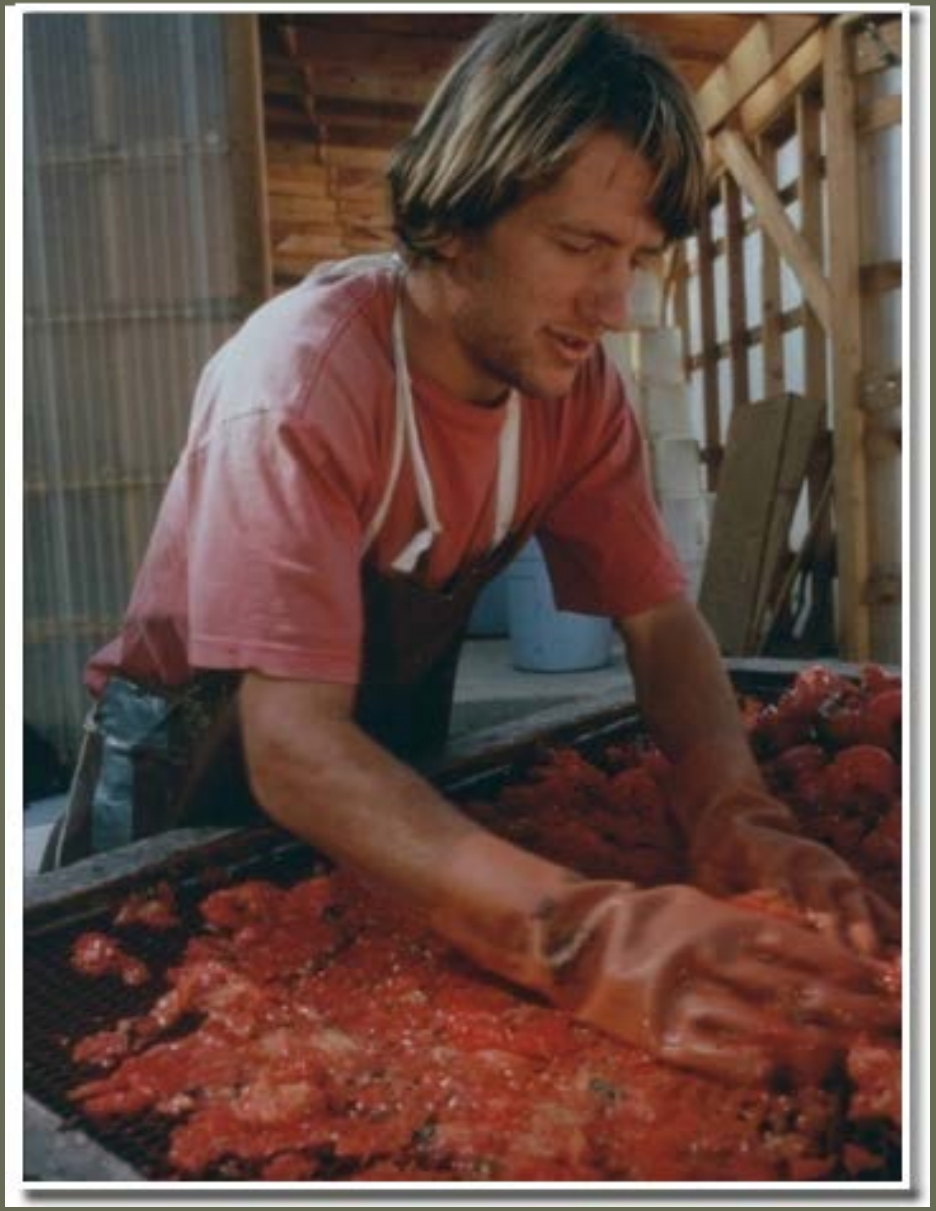
HARVEST/DRY
DRY SEEDED

- Allow plant to flower and set seed.
- Allow seed heads or pods to dry on the plant.
- Pull or cut plants .
- Dry plants.

Harvesting radish seed crop into windrows

Endive seed crop laid in a windrow to dry on geotextile cloth

Drying beet seed in a greenhouse on tables



HARVEST/DRYING
WET SEEDED CROPS

- Gauge the ripeness of the fruit you are harvesting by color, texture, and size.
- Harvest at the optimum ripeness for maximum viability of your crop.

Harvest the fruit when it is ripe. Clean seed from pulp.

Allow to set 2-3 days in warm location until fermentation begins.

Rinse, decant and collect seed. Place on screens and allow to dry

CLEANING TECHINQUES
Threshing, Winnowing, Screening

THRESHING

Threshing is the process used to break up the plant material and release the seed. It is a typical step before cleaning.

Threshing can be done with a machine but also by

- Rubbing seed heads between your hands.
- Rolling up a tarp and stepping on it.
- Stomping seeds in a bucket or bag.

All crop thresher

Belt thresher

WINNOWING

Winnowing is the process of using an air current to separate seed from non-seed material based on weight.

The heavier materials fall closer to the wind source while lighter materials are carried further from the wind source.

Box fans are excellent for gravity separation. Notice two containers

Light seed and chaff

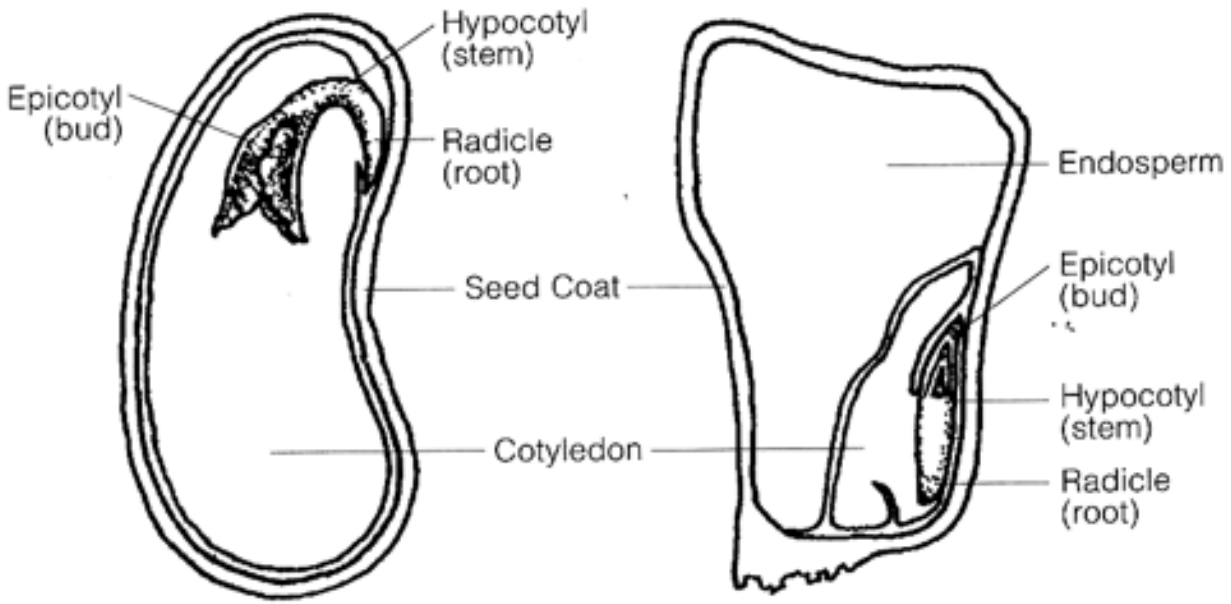
Heavy seed

SCREENING

Separation by size after threshing or winnowing.

Remove larger chaff – “top screening”. Remove smaller debris – “bottom screening”.

5b. STORING SEED



A seed and its many parts.

To maximize the life of your seed keep it

- Cool.
- Dry.
- Protected from insects and rodents.

THE most important thing to remember is that the seed should be very dry before it is placed in storage.

Every seed has a different longevity based on how it is stored.

A general rule for typical* storage:

1 year: onion, parsley, parsnip, salsify.

2 year: dandelion, sweet corn, leek, okra, pepper.

3 year: asparagus, beans, carrot, celeriac, celery, chervil, Chinese cabbage, kohlrabi, pea, spinach.

4 years: beets, Brussels sprouts, cabbage, cauliflower, chicory, eggplant, fennel, kale, mustard, pumpkin, rutabaga, squash, Swiss chard, tomato, turnip, watermelon.

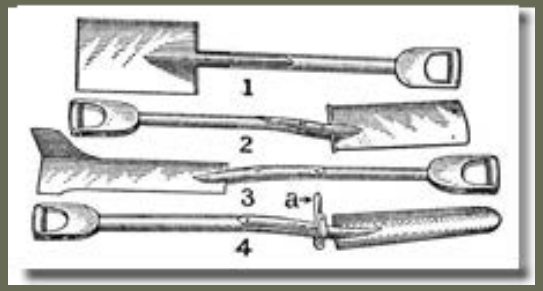
5 years: cardoon, collards, endive, lettuce, muskmelon, radish, water cress.

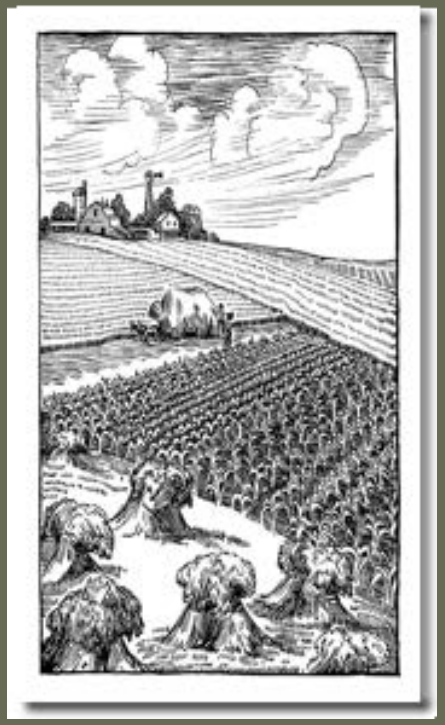
*typical might look like ambient indoor conditions

The longevity of a seed also depends upon the TEMPERATURE and DRYNESS in which it is stored.

- For example, a typical life span of a bean is 3 years. But, with optimum coldness and dryness, a bean seed can last up to 10 years, 20 years if it's frozen.

- Dry matters a lot more than cold.





6. REVIEW: REFLECTING ON THE LEARNING

Reviewing the questions to ask and answer before growing seed.

1. Why am I saving seed?
2. What seed is best for me?
3. What biological principles are fundamental to seed saving?
4. What skills and techniques are needed to grow and save seed?