Variety Selection & Plant Breeding

Once you select the crop you want to grow, the most important decision is which variety (cultivar) to grow.

Considerations for selecting which variety to grow (Traits):
1) Adaptation
   a) Maturity
   b) Vigor
   c) Uniformity
   d) Cold/heat tolerance
   e) Yield
2) Disease resistance
3) Quality
   a) Extended shelf-life
   b) Enhance nutritive value
   c) Improved flavor/appearance

Where do plant breeders find these improved traits?
   New cultivars
   Old cultivars
      Landraces
      Non-domesticated varieties
      Closely related species
   Centers of Origin = Centers of Diversity

Genes control traits
- Genes determined by DNA
- Estimated ~20,000 genes determine the individual (6,000 genes identified & confirmed in Arabidopsis)
- Plant breeders work to make new combinations of these genes, sometimes to move one gene for simple traits (e.g. disease resistance), or many genes for more complicated traits (e.g. yield).
- Pollination: Transfer of pollen from the anther to the stigma.
- Cross: pollen from one plant is transferred to stigma of another plant to create hybridized seed.
- Self: pollen from one plant is transferred to stigma of the same plant (or plant with the same genetic constitution).

Reproductive Flower parts:
- Stamen: Anther & Filament
- Pistil: Stigma, Style & Ovary

Flower Types:
- Hermaphroditic: Flowers with both Pistils and Stamens (Perfect)
- Staminate: Flowers with only stamens (Male)
- Pistillate: Flowers with only pistils (Female)
Types of plants:
- Monoecious: Male and Female flowers on the same plant
- Dioecious: Male and Female Flowers on different plants (e.g. spinach & asparagus)
- Andromonoecious: Male and Perfect flowers on the same plant

What breeders do: Identify genetic variation (different traits = genes), make crosses in order to create new combinations between different traits, select the best new trait combinations.

Two types of variation: Genetic & Environmental

1) Types of reproduction in vegetable crops:
   i) Self-pollinated
   ii) Cross-pollinated
   iii) Vegetatively propagated

   1) Self-pollinated crops
      a) No inbreeding depression
      b) Pure lines developed that are mostly homozygous (identical alleles (genes) on homologous chromosomes)
      c) Cultivars are often inbred lines – seed collected from cultivar will be identical with minimal isolation.
      d) Many crops utilize self-pollinated cultivars, but some crops do utilize hybrid cultivars (e.g. tomatoes are self-pollinated, but most modern cultivars are hybrids). Key factor: Hybrid vigor (heterosis) – the F1 hybrid outperforms either of the parents.
      e) If you grow an F1 hybrid, the seed from this hybrid will not be identical to the cultivar it came from.

   2) Cross-pollinated crops
      a) Often have inbreeding depression (maize is traditional example, vegetables include onion, carrot (most severe inbreeding depression), cucurbit crops (some with moderate to severe inbreeding depression), crucifer crops (mostly moderate inbreeding depression))
      b) Usually have Hybrid vigor: hybrid outperforms both parents
      c) Usually have some mechanism to prevent or reduce self-pollination
         i) Separate male & female flowers (dioecious or monoecious)
         ii) Stigma receptive before or after pollen shed
         iii) Self-incompatibility (genetic factor preventing self pollen from either germinating on stigma or growing through style)
      d) Modern Cultivar is usually F1 hybrid

   3) Vegetatively propagated crops
      a) Asparagus, potatoes, sweet potatoes, globe artichokes, rhubarb, garlic and horseradish
      b) If superior plant identified, it can be maintained as a clone via vegetative propagation
      c) Creating the variation is usually the problem
         i) If you can’t cross, must rely on mutations
      d) Another issue is maintaining clean plants (e.g. virus-free)