Potatoes - *Solanaceae* family

Cultivated potato - *Solanum tuberosum*

- Tetraploid (2n = 4x = 48 chromosomes)
- annual dicot
- clonal propagation (the tuber)

Can graft most related species

- tobacco confers pest resistance (nicotine) in tobacco-potato scion without permanently contaminating the tuber

Origin

- origin of domestication in Andes of Peru and Bolivia
- primitive cultivars (landraces) distributed widely from W. Venezuela to N. Argentina (along the Andes)
- ploidy ranges from 2x - 5x

Cultivars crossed with wild species as it spread north - these were distributed from SW US down to Chile

- there are roughly 190 wild species, including hexaploids

Potato Utilization in U.S.

- 34% frozen, 28% fresh, 12% into chips, 10% dehydrated, 15% seed and on-farm consumption, 1% canned
- many sold as ornamentals

History

Cultivated for more than 7000 yrs

Late blight (an oomycete) devastates Ireland potato crop

* only one variety was grown at the time.
* grain was used as currency for English landlords
* 50% of population died, many moved to US

World Production

- 4th leading world crop following wheat, rice, corn
- most protein/acre
- US production dropped in 2004-5 with advent of Atkins low-carb diet, but reestablished once we recognized that potatoes are not unhealthy

Oregon produces 37,100 acres (about 22 mil Cwt)
PNW is a great climate for potato yield and quality
→ long temperate clear days and cool nights facilitates less respiration and greater carbohydrate storage

Seed Production

- high water and carbohydrate yields large seed
  → tuber is divided into 4 for propagation

**clonal propagation is great vector for disease!

- seeds can be certified = become expensive

Cold storage: - increases cost
- increases sugar content (less starch) = poor cooking quality
→ working on a creating a variety to minimize starch-to-sugar conversion

Cassava - *Manihot esculenta*

General info

- monoecious, pollinated by wind and insect
- can be cloned, but suffers inbred depression
- usually diploid (2n = 36 chromosomes)
  wild polyploids, triploids yield most
- unisexual inflorescence
  - challenge to get group of plants to flower together

Genetic diversity

- Major center of diversity is Brazil, Central America is minor
- Wild species from southern US to northern Argentina

**cultivars have only 25% the diversity of wild relatives = difficult to improve genetically

- morphology largely controlled by environment
  → makes it tough to distinguish varieties using phenotype

Following introduction to Africa (1600s), there was difficulty getting plants to flower together in certain African environments. Centralized breeding does not fully consider local environment. New accessions were successfully introduced from Latin America based on environmental adaptation.

Environmental Adaptation

- adapted to topics and subtropics
  *fares well in humidity where others (ex. grains) get root rot
- tolerates drought and poor soil fertility (can survive many months without water once mature)
- can manage 5-6 tons/hectare in tough conditions, 40-60 in optimal
- harvest at 8 months, though roots can maintain up to 2 yr in soil

World Production and Use

- 5th leading world crop
- leading production in Africa (Nigeria)
- Asia is second - mostly produce for feed and industrial use
- about 20% world production used for animal feed
- little world trade (~ 11%)

Cultivation

- propagate stem cuttings (100% regeneration)
  → seed germination = only 30% and poor taproot
- usually grown as intercrop with vegetables or plantation crops

Diseases and Pests

- mosaic virus, spread by insect
- bacterial blight
- green mite, mealybug, grasshopper

Processing

- must process quickly (rapid deterioration)
- sweet types can be eaten raw, bitter types have cyanogenics

Peel and grate, press, dry → flour (processing detoxifies cyanogenics)

Nutrition

- roots are high in starch, low in protein and vitamins
- edible leaves are high in protein and vitamins (A, B)

Sweet Potato - *Ipomoea batatas*

- perennial, but dies back annually (herbaceous)
- harvested as annual in temperate climates

2 main types:

- white flesh, low moisture tuber, not very sweet
- orange flesh, high moisture tuber, quite sweet

- 50% used as animal feed in Asia, mostly human consumption in Africa
- high in vitamin A and C

Yams - *Dioscorea* family

- monocot, polyploids
- perennial grown as annuals
- climbing vines
- pollinated by insects

*propagated from pieces of tuber (~ 30% grown for seed)

- grown as intercrop with corn or others

Yams are a staple crop in Africa. They produce 96% of world supply.

- long storage time (4-6 month)
- high in vitamin C and potassium, more fiber than potato
- often eaten as paste (pounded yam) or flour

Plantain and Banana - *Musa* family

General Info

- large perennial herbs
- origin in SE Asia
- triploid (2n = 3x = 33 chromosomes)

* most are sterile/no seeds

Varieties - from AA x BB crosses
- AAA: desert banana (Africa), not as sweet, used for cooking and beer
- AAB: plantains
- ABB: also desert bananas

Leaves grow off pseudostem, support the large inflorescence (fruit). Real stem (corm) elongates from pseudostem following vegetative stage and inflorescence emerges.

Mostly consumed locally. A staple crop for East Africa. Short shelf life.

Asia is leading banana producer. Africa leads significantly in plantain production.

Nutrition and Uses
- high in potassium and vitamin A, B6, C
- can be baked, fried, roasted, pulped, chipped, or fermented
- used as animal feed
- leaves and pseudostem used in textile manufacturing

Disease and Pests
- mosaic virus, fungal leaf spot, Fusarium
- weevils and nematodes can account for up to 85% of losses

***** degredation of fertile soil

Legumes - *Fabaceae (Leguminosae)*

Unique Characteristics
- fix nitrogen from atmosphere (symbiotic relationship with N-fixing bacteria)
  * probably evolved in low fertiliy (low N) soil
- distinctive flower and ***pod***

Uses - different types of legumes
- animal forages
- dry grain (pulses, grain legumes, cold and warm season)
- oil seed
- vegetable (seeds, pods, leaves)
- fermented

Nutrition

Positive health:
- high in protein (nitrogen…), 20-35%

  proteins complement cereals (legumes are high in lysine and low in sulfur-containing methionine and cysteine)

- good source of iron, vit B, folic acid, soluble fiber
  - it is possible to survive on a 3:1 cereal:legume diet

Asia, W. Europe: pea, lentil or chickpea + cereal
Africa: cowpea + sorghum or millet
New World: common bean + maize
Also: soybean and rice

Anti-nutritional: (many)
- lectins, trypsin inhibitiors, phytate
- tannins (inhibit nutrient uptake)
- most are inactivated by cooking

World production
- oil seed: soya > groundnut
- vegetable: green pea and green bean > legume veggies and string bean

Changes with Domestication
- increase in seed size
- loss of seed dormancy (the hard shell which prevents entering moisture
- decrease in pod dehiscence (splitting/seed dispersal)
- from vine to bush (habit)
- decrease in anti-nutritional factors

Common Bean - *Phaseolus vulgaris*
- grows in the warm season
- diploid (n = 11 chromosomes)
- self pollinates
- dry bean for seed, snap bean for pod

Centers of origin - view map of Americas
Centers of domestication
- Andean (large seed)
- Meso American (small and medium seed)

Growth habits
- Type I: bush (early maturity and compactness)
- Type II: upright short vine (produces in bad weather)
- Type III: sprawling
- Type IV: climbing

Plant structure
- resistant to stem and root lodging
- narrow branch angles
- thick main stem
- pods in the upper half of the canopy, held loosely against stem

Diseases
-white and gray mold, root rot (Fusarium)

Peas - *Pisum sativum*

- diploid (2n = 14 chromosomes)
- self pollinated (no hybrid cultivars)
- grows in cool season (tough to grow in humidity)

Domestication

- center is fertile crescent, then Ethiopia, Europe, and eastern Asia
- changes following domestication include seed size, seed dormancy, plant height, dehiscence, and pigment variability

Types

- shell vs. snow vs. snap
  → shell and snap are high fiber = maintain shape with drying
- wrinkled vs. round
  → wrinkled have more sugar

Breed for: thick succulent pods, sweetness, stringless, virus/disease resistance, short vine, stiff stem

Stringlessness reduces lignin throughout plant (and thus plant vigor). Can grow in hot conditions to improve vigor in stringless types.

Diseases (Oregon)

- mosaic virus, mildew

<u>Beans for the Developing World</u> - Africa

- grown in moderate climate of highlands, more rainfall
- mostly for subsistence
- intercropping systems

Major Constraints

- heat and drought
- many pests and diseases (see list)
- No Infrastructre!

*Must breed to tolerate climate and disease/pests
Also, reduce anti-nutritional factors (phytate) and reduce cooking time