Legume Crops

- Family: Leguminosae
  - Feature: Nodules on the roots contain bacteria that "fix" nitrogen from the atmosphere
- Common Beans (Snap Beans, Dry Beans)
  - *Phaseolus vulgaris*
- Lima beans
  - *Phaseolus limensis* (large seeded, perennial)
  - *Phaseolus lunatus* (small seeded, annual)
- Pea
  - *Pisum sativum* (Garden Pea)
  - *P. sativum* var. macrocarpon (edible pods)
- Southern Pea
  - *Vigna unguiculata*
- Other Legumes:
  - Scarlet Runner Bean (*Phaseolus coccineus*)
  - Soybeans (*Glycine max*)
  - Fava Beans (*Vicia faba*)
  - Garbanzo Beans (*Cicer arietinum*)
  - Mung Beans (*Vigna radiata*)

Nodules: Bacteria convert $N_2 \rightarrow NH_4^+$
Nitrogen Fixation

- Bacteria in the Family Rhizobiaceae form a symbiotic relationship with the plant
  - Azorhizobium spp.
  - Bradyrhizobium spp.
  - Mesorhizobium spp.
  - Rhizobium spp.
  - Sinorhizobium spp.
- Closely related to Agrobacterium tumefaciens

Different Rhizobium Bacteria infect different Crops

<table>
<thead>
<tr>
<th>Rhizobium Species</th>
<th>Legumes Infected</th>
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</thead>
<tbody>
<tr>
<td><em>Rhizobium phaseoli</em></td>
<td>Beans</td>
</tr>
<tr>
<td><em>Rhizobium leguminosarum</em></td>
<td>Garden peas, Lentils, Vetches, Winter peas</td>
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<tr>
<td><em>Bradyrhizobium japonicum</em></td>
<td>Soybeans, Cowpeas, Lespedeza, Lima Bean, Peanut, Kudzu</td>
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</tbody>
</table>
• Efficient nitrogen fixation may require inoculation with appropriate bacteria species
• Other factors affecting nitrogen fixation:
  – Soil pH (reduced bacterial growth <6.0)
  – Temperature
    • Rhizobia do not grow below 10°C or above 37°C
  – Mineral Nutrition
    • Generally more Phosphorus required when fixing N
    • Iron & Molybdenum required
    • Excess N limits nodulation

Common Bean

• Snap beans (green beans, wax beans, Romano/Italian beans)

• Horticultural beans ("Shelled" beans)
  – Immature pods

• Dry Beans (Kidney beans, navy beans, pinto beans)
  – Immature seeds

• Types:
  – Indeterminate type (*Phaseolus vulgaris*)
  – Determinate type (*P. vulgaris* var. *humilis*)
  – Also Semi-determinate types

Snap Beans

• Old varieties have a tough, string-like tissue along one edge of the pod ("String" Beans)
• Pod colors vary from green, to yellow to purple
• Pod shapes include skinny, round or flat, and long or short
• May have 4 to 12 seeds/pod
Lima Beans

- Large seeded
  - *Phaseolus limensis*
  - *P. limensis* var. *limenanus*
  - Indeterminate type
  - Perennials grown as annuals
- Small seeded
  (Butter beans)
  - *Phaseolus lunatus*
  - *P. lunatus* var. *lunonanus*
  - Indeterminate type
  - Annual; 2 to 6 seeds/pod

Snap Beans & Lima Beans

- Center of Origin: Central & South America (all *Phaseolis* sp.)
- Native Americans grew beans & corn together (first documented example of intercropping)
- Typically grown similar to agronomic crops
  - Highly mechanized, machine harvested
  - Relatively cheap to produce a crop
    - Ave. worker hours/acre = ~8
      (Ave. worker hours/acre for lettuce = ~30)
- Majority of crop is processed (frozen or canned)

Climatic & Cultural Requirements

- Warm-season - but not too hot (<90°F)
- Not frost tolerant (>50°F)
- Optimum growth: 70 – 80°F
- Optimum seed germination: 80°F
  - Range: 60-85°F
- Modest fertilizer requirements
Planting & Crop Establishment

• Direct seeded
  – Snap Beans: 1-½” to 2” spacing
  – Lima Beans: 3” to 4” spacing
  – Indeterminates: 6” to 12” spacing
• Usually planted in rows for cultivation
• Often grown under dryland conditions, but need adequate moisture especially during flowering

Harvest & Postharvest Handling

• Most are mechanically harvested
• Immature pods & seeds are highly perishable
• Optimum storage: 40°-45°F, 90-95% RH
  – Chilling injury <37°F
• Shelf-life:
  – Snap Beans: 7-10 days
  – Lima Beans: 5-7 days
• Dry Beans: 6 to 10 month shelf-life @ 40°-50°F and 40-50% RH
  – Need at least 14% moisture to prevent cracking

Southern Pea

• AKA: Cowpea, Field pea, Black-eyed pea, Purple hull pea
• Vigna unguiculata
• Center of Origin: India
• Traditionally a Southern Crop
• Much more tolerant of heat and insects
• Tolerant of poor soils & low fertility – can be a cheap crop to produce
Pea

- *Pisum sativum*
- Center of Origin: Europe or North Asia
- Some consider pea to be oldest cultivated vegetable – 9760 B.C. (Carbon dating)
- Annual
- Self pollinated
- Cool Season Crop
- Marketed Fresh and Dried

Edible Pod Peas

- *P. sativum var. macrocarpon*
  - Snow peas: flat immature pods are eaten
  - Sugar snap: low fiber pods formed tightly around the seeds; may be eaten like snap beans

Vine Types

- Indeterminate and dwarf or semi-dwarf, not determinate
- Flowers develop in clusters near the end of the shoot, the fruit load stops shoot development, so appears to be determinate
Plant Growth & Development

- Cotyledons remain below the soil surface
- Compound leaves terminate in tendrils
- A leafless form, *afila*, is where the leaves are converted to tendrils (still have stipules for photosynthetic area)
  - *Afila* plants tend to support each other in high density, growing more upright without support
- Flowering determined by node number, and remains constant for a particular variety

Fruit Development

- Fruit is a pod consisting of an ovary with two rows of ovules which develop into seeds
- As seeds mature, sugar is converted to starch
- Edible pod peas the pod endocarp remains soft and succulent
- Most cultivars have the potential for 8-10 peas/pod or more, but this potential is usually not reached under field conditions

Climatic & Cultural Requirements

- Optimum temperature: 50o-64oF
- Maximum temperature: 75oF
  - increase fiber and starch content, lower yields
- Can tolerate light frost, but minimum temperature for growth ~45oF
- Susceptible to root rots in wet soils
- Often require 4 year rotations to avoid root rots
Planting & Crop Establishment

- Entirely direct seeded
- Processing types are the dwarfed type, seeded with grain drills in rows 6”-8” apart and 1-½” to 2” between plants (high density)
- Fresh market & home gardens usually use taller types in rows 2’-3’ apart and 2” between plants
- Dwarf types have capacity for higher yields with high density plantings

Harvesting

- A heat unit system is used to time maturity for processing harvest
  - Based on base temperature of 40°F and 85°F maximum temperature
  - The daily heat units calculated based on the daily mean temperature
  - Each cultivar has a specific heat unit requirement
  - Used by processors to time their fields so they can have a constant supply and not be overloaded with product needing processing

Harvesting

- Proper stage at harvest is critical for maximum quality and yield
  - Maximum yields obtained from mature seed
  - Quality rapidly goes down as the seeds mature
- Edible pod peas particularly sensitive to over maturity
  - Optimum quality obtained when harvested with 12 to 24 hours of optimum maturity
- Processing peas harvested by machine
- Fresh market peas harvested by hand
Postharvest Handling

- Peas lose sugar rapidly under warm conditions
- Fresh peas can be stored 1 to 2 weeks at 32°F and 95-98% RH
- Processing peas should be canned or frozen immediately after harvest for maximum quality