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*)

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)
• Dry Beans (Kidney beans, navy beans, pinto beans)
• 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 Phaseolus 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
  - 9750 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 leave 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 40oF and 85oF 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
- 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 loose 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