Organic Crop Production:
Crop Rotation
Annette Wszelaki
Vegetable Specialist

Well-thought-out crop rotation is worth 75% of everything else that might be done, including fertilization, tillage and pest control.

-Firmin Bear

What is crop rotation?
- Crop rotation is selecting a sequence of crops for a field that improves soil quality while it sustains the farmer.

Why rotate?
- Maintains good soil health and quality
- Fosters the most effective use of soil fertility
- Helps control weeds, some diseases and insects
- Reduces need for off-farm inputs
- Enhances moisture management
- Promotes income diversity and stability
- Improves crop quality and yields
- Reduces soil erosion
- Increases biodiversity
- Improves water quality
- Reduces drought impact

Decisions, decisions...
- With a 3 crop, 4 year rotation, there are 6 possible sequences
- With a 3 crop, 8 year rotation, there are 5,040 sequences!

Why bother?
- A good rotational sequence can accentuate every possible advantage
- Different crops use soil nutrients differently
- All may alter or be altered by the succeeding or preceding crop
- Time spent planning a rotation is never wasted!
- THINK IT THROUGH!
Insect, Disease and Weed Control

- Monoculture encourages pest problems
- A good rotation can prevent the build-up of specific pests and weeds

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Plant Nutrition

- Rotations can make nutrients more available
- Plants of a lower order of evolution better feeders on less soluble sources of nutrients
  - i.e., alfalfa, clovers and cabbage versus lettuce and cucumbers

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Soil Structure

- Rotations preserve and improve soil structure
- Maximize benefits of crops with different rooting depths

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Yields

- Some crops helped, others hindered by preceding crop
- How they help:
  - Increase soil N
  - Improve soil condition
  - Increase microbial activity
  - Excrete beneficial substances
  - Control pests
- How they hinder:
  - Deplete soil nutrients
  - Excrete toxic substances
  - Increase soil acidity
  - Make soil condition unfavorable
  - Lack of proper aeration
  - Remove moisture
  - Vector disease

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Things to consider:

- Number of blocks or sections
  - Rotation works best if sections are all the same size
- Number of years in rotation cycle
  - 10 sections does not necessarily = 10 year rotation
  - Do what makes sense for your operation!
- Number of crops in rotation
  - Most small growers have many diversified crops
  - Crops must be further divided based on botanical classification, plant part consumed or space utilized

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Rotation Lengths to Reduce Soilborne Pathogens

<table>
<thead>
<tr>
<th>Vegetable</th>
<th>Disease</th>
<th>Yrs w/o Susceptible Crop</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asparagus</td>
<td>Fusarium rot</td>
<td>8</td>
</tr>
<tr>
<td>Cabbage</td>
<td>Clubroot</td>
<td>7</td>
</tr>
<tr>
<td>Cabbage</td>
<td>Blackleg</td>
<td>3-4</td>
</tr>
<tr>
<td>Cabbage</td>
<td>Black rot</td>
<td>2-3</td>
</tr>
<tr>
<td>Muskmelon</td>
<td>Fusarium wilt</td>
<td>5</td>
</tr>
<tr>
<td>Parsnip</td>
<td>Root canker</td>
<td>2</td>
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<tr>
<td>Peas</td>
<td>Root rots</td>
<td>3-4</td>
</tr>
<tr>
<td>Peas</td>
<td>Fusarium wilt</td>
<td>5</td>
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<tr>
<td>Pumpkin</td>
<td>Black rot</td>
<td>2</td>
</tr>
<tr>
<td>Radish</td>
<td>Clubroot</td>
<td>7</td>
</tr>
</tbody>
</table>

Source: S.A. Johnson & P.J. Nitzche, USDA
Crop Families

- **Brassicaceae (Cabbage Family)**
  - Cabbages, cauliflowers, kale, broccoli, turnips, radishes, mustard, Brussels sprouts
  - Can have allelopathic effect on subsequent crops

- **Solanaceae (Tomato Family)**
  - Tomatoes, potatoes, peppers, eggplant (okra)
  - Need fairly high level of nitrogen
  - Potato prefers soil slightly more acidic

- **Fabaceae (Bean Family)**
  - Snapbeans, lima beans, broad beans, half-runners, field peas, English peas
  - Fix nitrogen from the air for their own fertilizer and for subsequent crop

- **Alliaceae (Onion Family)**
  - Onions, leeks, shallots, garlic
  - Monocot

- **Cucurbitaceae (Squash Family)**
  - Squash, cucumber, melons, pumpkins, gourds
  - Long growing season

- **Apiaceae (Carrot Family)**
  - Carrots, parsnips, parsley, celery, celeriac, dill
  - Dill enhances cabbage family, onion and lettuce

- **Chenopodiaceae (Chard Family)**
  - Beet, spinach, Swiss chard, lambsquarters
  - Mycorrhizae will not associate

- **Asteraceae (Lettuce Family)**
  - Lettuce, salsify, Jerusalem artichoke

- **Poaceae (Grass Family)**
  - Corn

Crop Space Requirements

<table>
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<tr>
<th>More Space</th>
<th>Less Space</th>
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<tbody>
<tr>
<td>6</td>
<td>1</td>
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<tr>
<td>Corn</td>
<td>Onion</td>
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<td>Potato</td>
<td>Beets</td>
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<td>Pea</td>
<td>Chard</td>
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<td>Parsley</td>
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<td>squash</td>
<td>Celery</td>
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<td>Parsnip</td>
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<td>Rutabaga</td>
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<td>Broccoli</td>
<td>Kale</td>
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<td>Bean</td>
<td>Brussels sprouts</td>
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<tr>
<td>Cabbage</td>
<td>Cucumber</td>
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<tr>
<td>Spinach</td>
<td></td>
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Nutrient Feeding

Some crops are *heavy feeders* that deplete soils, while other crops are *light feeders* that build soils.

- **Soil Depleting Crops**
  - Row crops- corn, soybeans, vegetables, potatoes

- **Soil Neutral or Soil Conserving Crops**
  - Cereal crops- wheat, barley, oats

- **Soil Building Crops**
  - Legume sods- alfalfa, clover
  - Grass sods- prairie grass, meadows, pastures
Potatoes follow sweet corn because research has shown corn to be one of the preceding crops that most benefit the yield of potatoes.

Sweet corn follows the cabbage family because, in contrast to other crops, corn shows no yield decline when following brassicas. Also, the cabbage family can be undersown to a leguminous green manure, which, when turned under the following spring, provides the most ideal growing conditions for sweet corn.
Coleman's 8-year Vegetable Crop Rotation

The cabbage family follows peas because the pea crop is finished and the ground is cleared (early) allowing a vigorous green manure crop to be established.

Coleman’s 8-year Vegetable Crop Rotation

Peas follow tomatoes because they need an early seedbed, and tomatoes can be undersown to a non-winter-hardy green manure crop that provides soil protection over winter with no decomposition and regrowth problems in the spring.

Coleman's 8-year Vegetable Crop Rotation

Tomatoes follow beans because this places them 4 years away from their close cousin, the potato.

Coleman’s 8-year Vegetable Crop Rotation

Beans follow root crops because they are not known to be subject to the detrimental effect of certain root crops, such as carrots and beets, may exert in the following year.

Coleman's 8-year Vegetable Crop Rotation

Squash is grown after potatoes in order to have two "cleaning" crops back to back prior to the root crops, thus reducing weed problems in the root crops.

Ogden's 4-year Rotation Cycle

leaf crops

legumes

fruit crops

root crops
Don’t forget cover crops or green manures in your rotation!

- Investment in weed and pest control
- Vegetable systems have many windows to include cover crops or green manures
  - Example: Between harvest of early planted spring crop and planting of fall crops
    - Buckwheat, cowpeas, sorghum-sudan
  - Plant winter annual on fields that would lie fallow
  - Many veg crops can be overseeded with cover
    - Select crops that can tolerate shade and traffic

Companion Planting

- Mix it up!
- All of one crop or crop family does not have to go in the same block!
- Three Sisters
- Herb-Vegetable Combinations

UT Organic Crops Field Tour

- May 15, 8 AM – 11:15 AM
- Pre-register with ETREC by calling 865.974.7201
- Visit http://organics.tennessee.edu for more info

Future Workshops

- Planting: Seed Sources & Transplants (May 11)
- Identifying and Managing Weeds (June 8)
- Identifying and Managing Pests (July 13)
- High Tunnel Production (August 10)
- Identifying and Managing Diseases (September 14)
- Developing an Organic System Plan (October 12)
- Marketing Organic (November 9)

Questions?

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Organic Crops Field Tour: May 15