Crop Rotation
(why and some ideas of how)

Wesley Crump
USU Extension County Horticulturist
Wasatch and Summit Counties
Outline

• Definition
• Why rotate?
• Methods
• Challenges
• How to work through challenges
• Resources
Definition

Crop rotation

- "Crop rotation refers to the sequencing of crops over time on a field or planting bed" ¹

- "Crop rotation involves rotating the planting of different crops, each with different nutritional needs, in succession in the same space." ²

Definition

Crop rotation

• "Rotation is the practice of using the natural biological and physical properties of crops to benefit the growth, health, and competitive advantage of other crops. In this process the soil and its life are also benefited. The desired result is a farm which is more productive and to a greater extent self-reliant in resources." ¹ (italics added)

¹ Don Kretschmann in Mohler & Johnson (eds.). (2009) Crop Rotation on Organic Farms a Planning manual. pg. 5
Crop rotation methods

Year 1
- Tomato
- Carrot
- Pea
- Cucumber

Year 2
- Pea
- Tomato
- Cucumber
- Carrot

Year 3
- Cucumber
- Pea
- Carrot
- Tomato

Year 4
- Carrot
- Cucumber
- Tomato
- Pea
Why rotate crops?

• Improve and maintain soil health

• Manage diseases and pests
Rotating crops to improve soil health

<table>
<thead>
<tr>
<th>Low</th>
<th>Medium</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beans (all)</td>
<td>Brassica greens</td>
<td>Broccoli</td>
</tr>
<tr>
<td>Beet</td>
<td>Cucumber</td>
<td>Cabbage</td>
</tr>
<tr>
<td>Carrot</td>
<td>Eggplant</td>
<td>Cauliflower</td>
</tr>
<tr>
<td>Herbs</td>
<td>Pepper</td>
<td>Corn</td>
</tr>
<tr>
<td>Peas</td>
<td>Pumpkin</td>
<td>Lettuce</td>
</tr>
<tr>
<td>Radish</td>
<td>Spinach, chard</td>
<td>Potato</td>
</tr>
<tr>
<td></td>
<td>Squash</td>
<td>Tomato</td>
</tr>
<tr>
<td></td>
<td>Sweet potato</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Watermelon</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Winter squash</td>
<td></td>
</tr>
</tbody>
</table>

*Note: Vegetables are classified as having low, medium, or high nutrient requirements. These categories do not account for differences among varieties.*

From Table 3.1 in Mohler & Johnson (eds) (2009) Crop rotation on organic farms a planning manual. pg. 29
Rotating crops to improve soil health

• Maintain adequate nutrient levels in the soil
• Maintain sufficient organic matter levels in the soil

From Table 3.1 in Mohler & Johnson (eds) (2009) Crop rotation on organic farms a planning manual. pg. 29
Rotating crops to improve soil health

• Maintain adequate nutrient levels in the soil
• Maintain sufficient organic matter levels in the soil
• Diversify and strengthen the microbiome in the soil
  • Crop rotation increases microbial biomass and diversity
  1, 2, 3, 4, 5
  • Different rotations have different profiles
  3
  • Decrease harmful fungi
  3

Rotating crops to improve soil health

• Maintain adequate nutrient levels in the soil
• Maintain sufficient organic matter levels in the soil
• Diversify and strengthen the microbiome in the soil
  • Crop rotation increases microbial biomass and diversity \(1, 2, 3, 4, 5\)
  • Different rotations have different profiles \(3\)
  • Decrease harmful fungi \(3\)
• Physical condition of soil

Rotating crops to manage diseases and pests

• Reduce the accumulation of pathogens to a given crop
Rotating crops to manage diseases and pests

• Reduce the accumulation of pathogens to a given crop

• “To manage a disease successfully with rotation, one needs to know:
  1. How long the pathogen can survive in the soil,
  2. Which additional plant species...it can infect or survive on,
  3. Other ways it can survive...
  4. How it can be spread or reintroduced...
  5. Methods for managing other pathogen sources”

1 Mohler & Johnson (eds) (2009) Crop rotation on organic farms a planning manual. pg. 32
Rotating crops to manage diseases and pests

• Crop rotation can be effective in managing some pathogens
  • Bacterial spot (pepper and tomato)
    • *Xanthomonas campestris pv. vesicatoria*
    • Can’t survive after plant debris has decomposed

Howard F. Schwartz, Colorado State University, Bugwood.org

Rotating crops to manage diseases and pests

• Crop rotation can be effective in managing some pathogens \(^1\)
  • Bacterial spot (pepper and tomato)
    • *Xanthomonas campestris pv. vesicatoria*
    • Can’t survive after plant debris has decomposed

• Bacterial speck (tomato)
  • *Pseudomonas syringae pv. tomato*
  • If remove all plant debris, only in soil for ~30 days

Rotating crops to manage diseases and pests

• Some pathogens hard to manage with rotation because they can live on any organic matter in the soil
  • Fungi: Pythium, Rhizoctonia, Fusarium
  • Bacteria: Erwinia, Rhizomonas, Streptomyces

• Other long-lived pathogens
  • Phytophthora, verticillium

• All is not lost!

Rotating crops to manage diseases and pests

• Some crops have inhibitory action on pathogens (biofumigation) ¹
  • Broccoli and other mustards
    • Lowered pressure of Verticillium wilt
    • High levels of secondary compounds derived from glucosinolates
  
• Hairy vetch lowered Fusarium wilt in watermelon ¹

• Sunflower before maize lowered *Fusarium graminearum* ²

• Cabbage, kidney beans, celery lowered *Pyrenochaeta* presence ³

2. Benítez, et al. (2017) Previous crop and rotation history effects on maize seedling health and associated rhizosphere microbiome. Scientific Reports 7:15709. DOI: 10.1038/s41598-017-15955-9
Rotating crops to manage diseases and pests

• Reduce the population build-up of insect pests
  • Making food source more difficult to find
  • Disrupting life/feeding cycles

• Increased mobility of pest = more difficult to control

• Western corn rootworm \(^1\)
  • Larvae only survive in great number when corn root available
  • Intensive corn planting has made this an issue

---

\(^1\) Mohler & Johnson (eds) (2009) Crop rotation on organic farms a planning manual. Pg. 41
Rotating crops to manage weeds

• Crop rotation can aid in weed control
  • Rotating crops with different planting times can disrupt weed germination and establishment
  • Rotating crops with varying degrees of competitiveness can help keep weeds at bay

• If possible, rotate in a cover crop instead of leaving bare soil
Crop rotation methods

Year 1: Tomato, Carrot, Pea, Cucumber
Year 2: Pea, Tomato, Cucumber, Carrot
Year 3: Cucumber, Pea, Tomato, Carrot
Year 4: Carrot, Cucumber, Tomato, Pea
Crop rotation methods

• Do not grow the same crop in the same space in succession
Crop rotation methods

• Do not grow the same crop in the same space in succession

• Rotate by botanical families
  • Solanaceae
    • Tomato, potato, pepper, eggplant, tomatillo
  • Brassicaceae
    • Kale, radish, cabbage, broccoli, cauliflower
  • Cucurbitaceae
    • Cucumber, squash, pumpkins, watermelon, melons
  • Fabaceae
    • Pea, bean, hairy vetch, peanut

• Poaceae
  • Corn, grasses
• Liliaceae
  • Onions, garlic, shallots, asparagus
• Apiaceae
  • Carrots, celery, cilantro, parsley
• Asteraceae
  • Lettuce
• Amaranthaceae
  • Spinach, beets, chard
Crop rotation methods

- Do not grow the same crop in the same space in succession
- Rotate by botanical families
- Rotate nitrogen demanding and nitrogen giving/light feeders

<table>
<thead>
<tr>
<th>Ranking annual vegetables based on relative nutrient requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
</tr>
<tr>
<td>-----</td>
</tr>
<tr>
<td>Beans (all)</td>
</tr>
<tr>
<td>Beet</td>
</tr>
<tr>
<td>Carrot</td>
</tr>
<tr>
<td>Herbs</td>
</tr>
<tr>
<td>Peas</td>
</tr>
<tr>
<td>Radish</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

Note: Vegetables are classified as having low, medium, or high nutrient requirements. These categories do not account for differences among varieties.
Crop rotation methods

• Do not grow the same crop in the same space in succession
• Rotate by botanical families
• Rotate nitrogen demanding and nitrogen giving/light feeders
• Rotate root crops with fruiting crops and leafy crops
Crop rotation methods

• Do not grow the same crop in the same space in succession
• Rotate by botanical families
• Rotate nitrogen demanding and nitrogen giving/light feeders
• Rotate root crops with fruiting crops and leafy crops
• Rotate crops with different root depths
Crop rotation methods

• Do not grow the same crop in the same space in succession
• Rotate by botanical families
• Rotate nitrogen demanding and nitrogen giving/light feeders
• Rotate root crops with fruiting crops and leafy crops
• Rotate crops with different root depths
• Rotate in cover crops (shoulder seasons if only time available)
Crop rotation methods

• Do not grow the same crop in the same space in succession
• Rotate by botanical families
• Rotate nitrogen demanding and nitrogen giving/light feeders
• Rotate root crops with fruiting crops and leafy crops
• Rotate crops with different root depths
• Rotate in cover crops (shoulder seasons if only time available)
• Within beds, rotate crops with differing growing times (spring, summer, fall sowings)
Challenges

• Small space + diverse crops = complexity
Challenges

• Small space + diverse crops = complexity
• Cash crop(s) dominates percentage of total crops grown
Challenges

• Small space + diverse crops = complexity
• Cash crop(s) dominates percentage of total crops grown
• Many different crops grown that are closely related (lots of brassicas!)
Challenges

• Small space + diverse crops = complexity
• Cash crop(s) dominates percentage of total crops grown
• Many different crops grown that are closely related (lots of brassicas!)
• Climate and management practices dictate what can grow where
Challenges

• Small space + diverse crops = complexity
• Cash crop(s) dominates percentage of total crops grown
• Many different crops grown that are closely related (lots of brassicas!)
• Climate and management practices dictate what can grow where
• Unexpected and unpredictable weather
Challenges

• Small space + diverse crops = complexity
• Cash crop(s) dominates percentage of total crops grown
• Many different crops grown that are closely related (lots of brassicas!)
• Climate and management practices dictate what can grow where
• Unexpected and unpredictable weather
• What about perennials?
Challenges

• Small space + diverse crops = complexity
• Cash crop(s) dominates percentage of total crops grown
• Many different crops grown that are closely related (lots of brassicas!)
• Climate and management practices dictate what can grow where
• Unexpected and unpredictable weather
• What about perennials?
• Where do cover crops fit in?
How do you deal with challenges?

• Okay great, but how does this relate to being a small-scale (urban) farmer in Utah?

• Crop rotation is an integral practice
  • Long, complex rotations can be very fruitful, but any is better than none

How do you deal with challenges?

• Okay great, but how does this relate to being a small-scale (urban) farmer in Utah?
• Crop rotation is an integral practice
• How to crop rotate will depend on your situation
  • CSA?
  • Wholesale?
  • Farmer’s Market?
  • Short growing season?
  • Organic? Conventional?
  • F) all the above?
How do you deal with challenges?

• Okay great, but how does this relate to being a small-scale (urban) farmer in Utah?

• Crop rotation is an integral practice

• How to crop rotate will depend on your situation

• Plan it out
  • Multiple contingency plans if able
How do you deal with challenges?

• Okay great, but how does this relate to being a small-scale (urban) farmer in Utah?

• Crop rotation is an integral practice

• How to crop rotate will depend on your situation

• Plan it out

• Keep records

[Diagram of crop rotation]

Extension
UtahStateUniversity
How do you deal with challenges?

• Okay great, but how does this relate to being a small-scale (urban) farmer in Utah?
• Crop rotation is an integral practice
• How to crop rotate will depend on your situation
• Plan it out
• Keep records
• Be creative
How do you deal with challenges?

• Okay great, but how does this relate to being a small-scale (urban) farmer in Utah?

• Crop rotation is an integral practice
• How to crop rotate will depend on your situation
• Plan it out
• Keep records
• Be creative
• Be flexible
Resources

• In-depth examples of crop rotations across wide range of farms
• Disease hosts reference
• In-depth crop rotation planning procedures