Extension
UtahStateUniversity

Crop Rotation

(why and some ideas of how)

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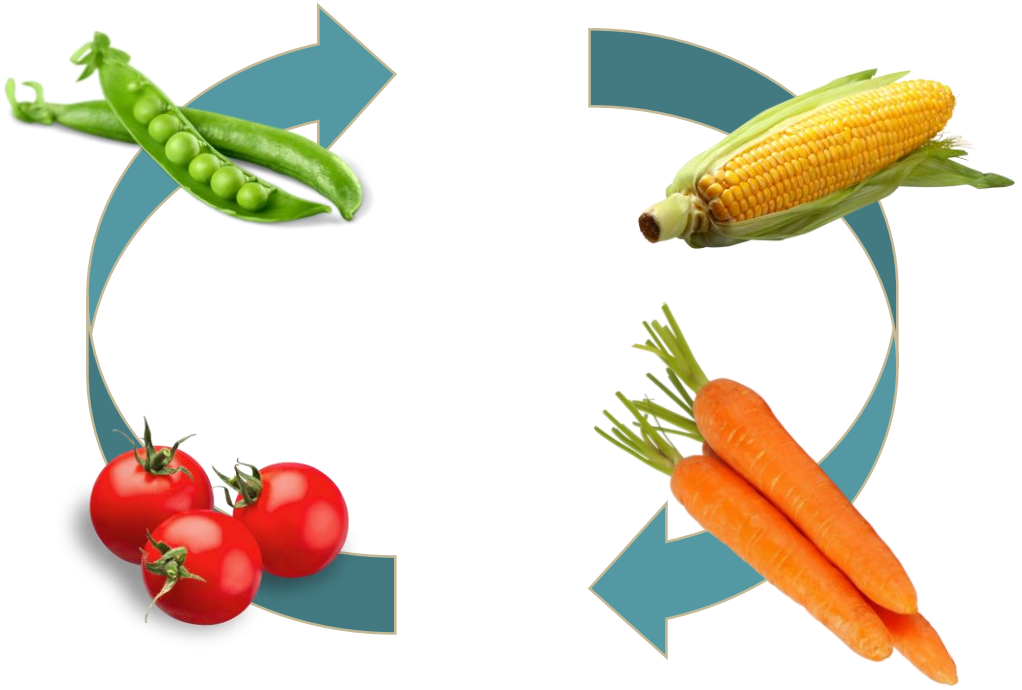
Outline

- 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]

1. Crop Rotation Practice Standard. https://www.ams.usda.gov/grades-standards/crop-rotation-practice-standard. Accessed 02/08/23
2. Hammonds (2017) Crop Rotation. https://smallfarms.cornell.edu/2017.edu/2017/05/21-crop-rotation/

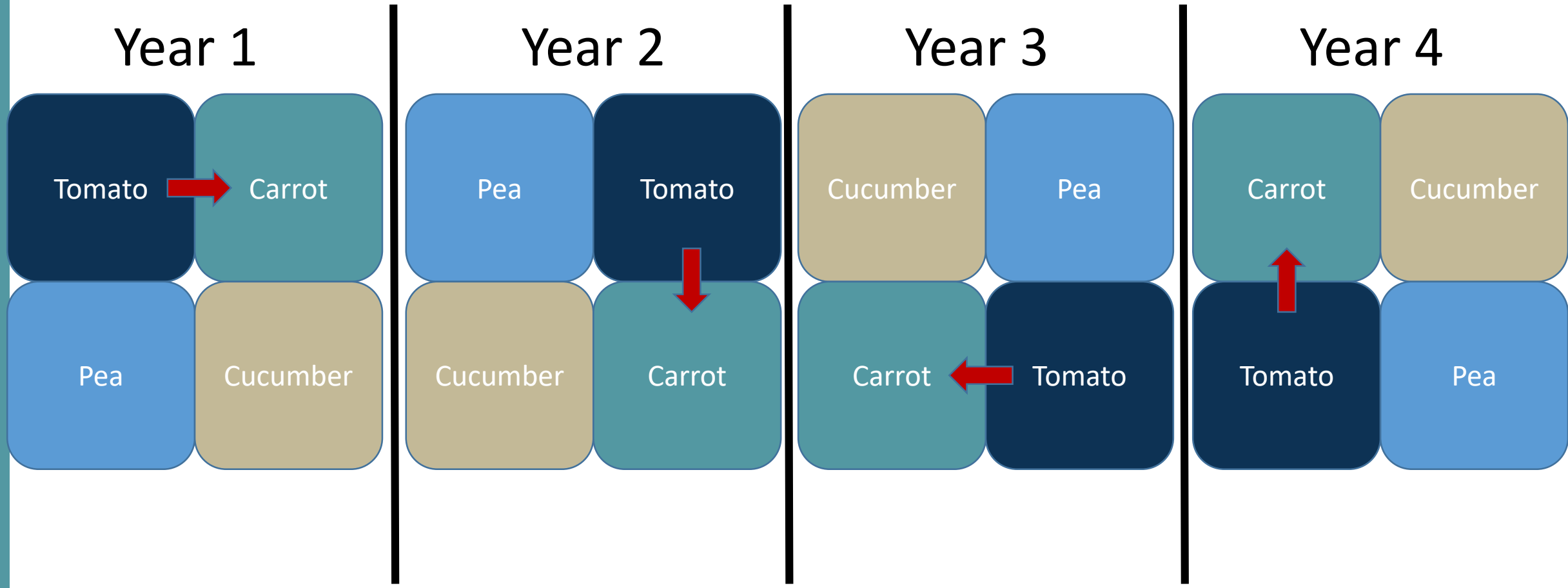
Definition

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

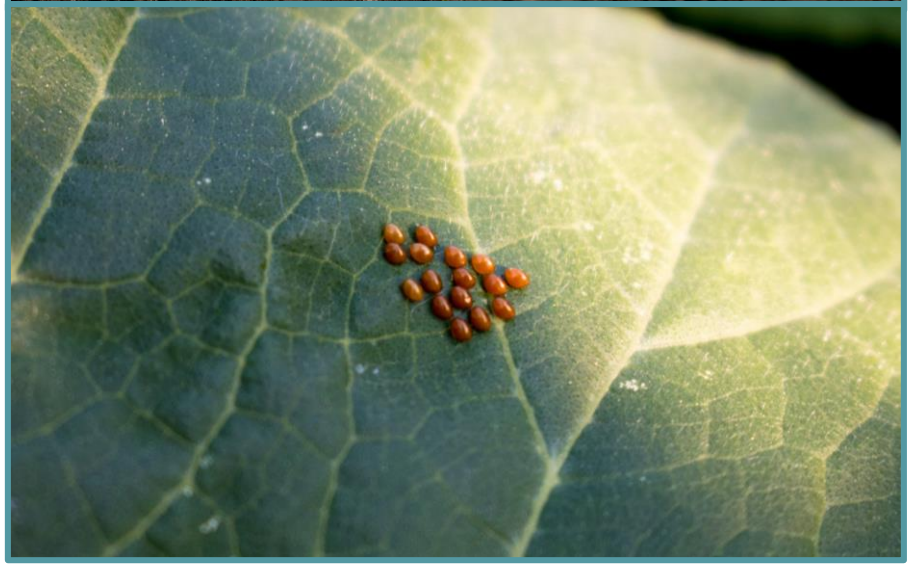
Crop rotation methods



Why rotate crops?

- Improve and maintain soil health

- Manage diseases and pests



Rotating crops to improve soil health

Ranking annual vegetables based on relative nutrient requirements		
Low	Medium	High
Beans (all)	Brassica greens	Broccoli
Beet	Cucumber	Cabbage
Carrot	Eggplant	Cauliflower
Herbs	Pepper	Corn
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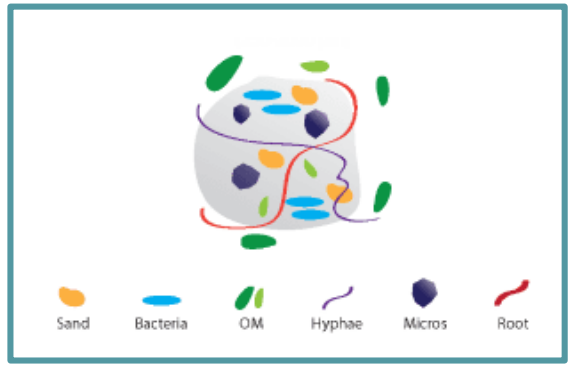
Note: Vegetables are classified as having low, medium, or high nutrient requirements. These categories do not account for differences among varieties		

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



NDSU Extension "Aggregates are a part of soil structure and function"

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]

1. McDaniel et al. (2014) Does agricultural crop diversity enhance soil microbial biomass and organic matter dynamics? A meta-analysis. Ecological Applications 24, 560-570
2. Ding et al. (2018) Dynamics of a soil fungal community in a three-year green garlic/cucumber crop rotation system in northwest china. Sustainability 10, 1391. DOI: 10.3390/su10051391
3. Lyu et al. (2020) Effects of different vegetable rotations on fungal community structure in continuous tomato cropping matrix in greenhouse. Frontiers in Microbiology 11:829. DOI: 10.3389/fmicb.2020.00829
4. Venter et al. (2016) The impact of crop rotation on soil microbial diversity: a meta-analysis. Pedobiologia 59, 215-223. DOI: 10.1016/j.pedobi.2016.04.001
5. Wang et al. (2017) Impact of root diversity upon coupling between soil C and N accumulation and bacterial community dynamics and activity: Result of a 30 year rotation experiment. Geoderma 292, 87-95. DOI: 10.1016/j.geoderma.2017.01.014

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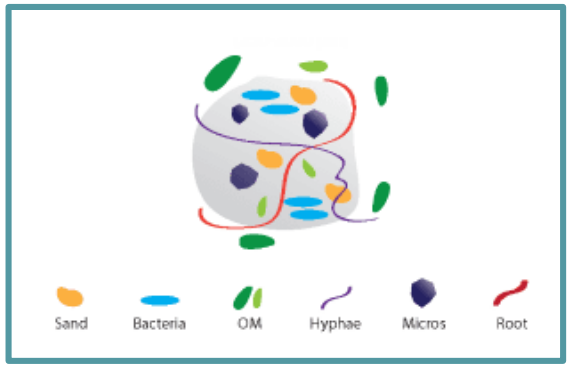
- Physical condition of soil



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Rotating crops to manage diseases and pests

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- "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]

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 [1]
  - 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

1. Mohler & Johnson (eds) (2009) Crop Rotation on Organic Farms A Planning Manual. Pg. 36 – 40

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  - 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

1. Mohler & Johnson (eds) (2009) Crop Rotation on Organic Farms A Planning Manual. Pg. 36 – 40

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 [1]
  - Fungi: *Pythium, Rhizoctonia, Fusarium*
  - Bacteria: *Erwinia, Rhizomonas, Streptomyces*

- Other long-lived pathogens [1]
  - *Phytophthora*, *verticillium*

- All is not lost!

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1. Mohler & Johnson (eds) (2009) Crop rotation on organic farms a planning manual. Pgs. 36-40

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]

1. Mohler & Johnson (eds) (2009) Crop rotation on organic farms a planning manual. Pgs. 36-39
2. Benitez, 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
3. Lyu et al. (2020) Effects of different vegetable rotations on fungal community structure in continuous tomato cropping matrix in greenhouse. Frontiers in Microbiology 11:829. DOI: 10.3389/fmicb.2020.00829

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

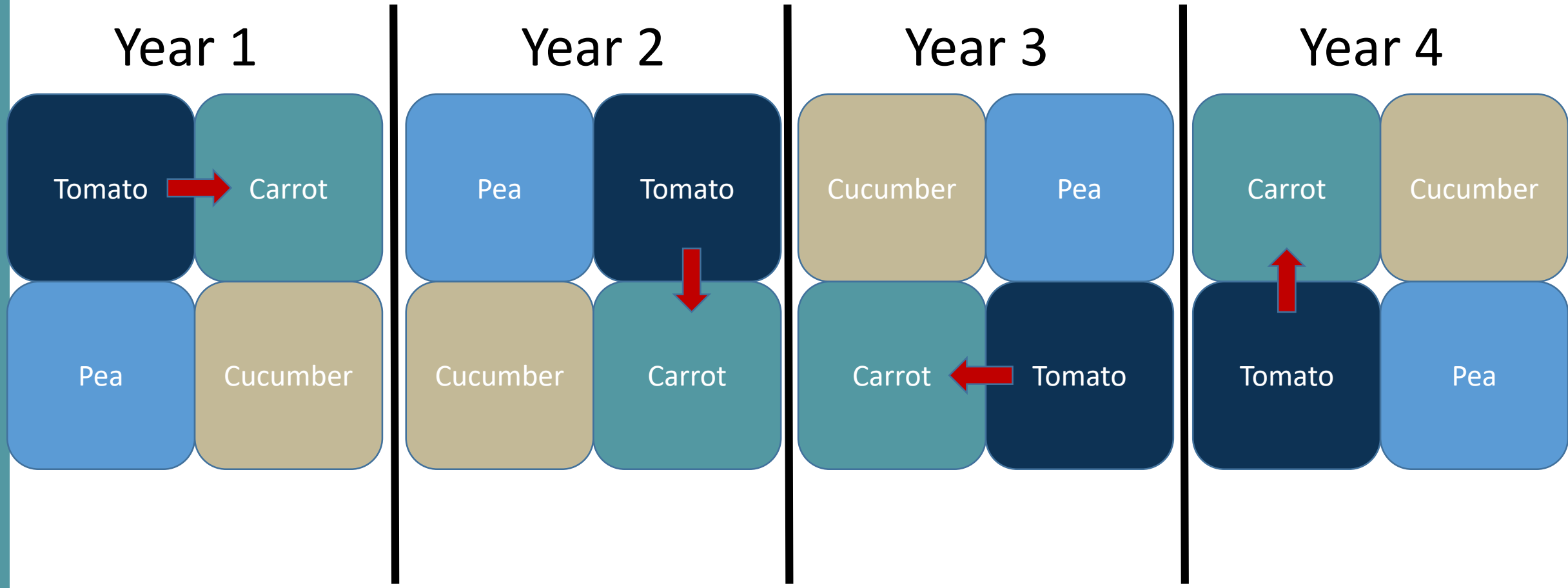
Frank Peairs, Colorado State University, Bugwood.org

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



Crop rotation methods

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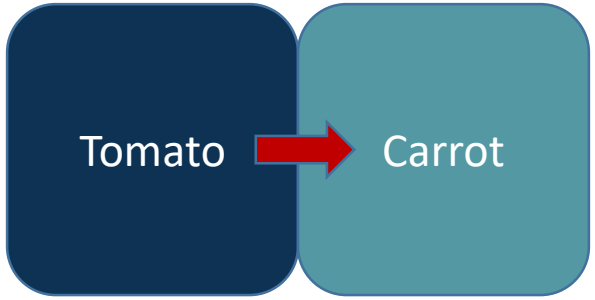

Crop rotation methods

- 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

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- Rotate nitrogen demanding and nitrogen giving/light feeders

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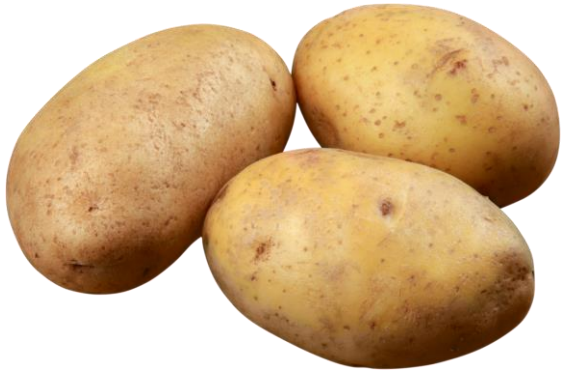
- Rotate root crops with fruiting crops and leafy crops
- Rotate crops with different root depths



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- Rotate in cover crops (shoulder seasons if only time available)
- Within beds, rotate crops with differing growing times (spring, summer, fall sowings)

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- What about perennials?

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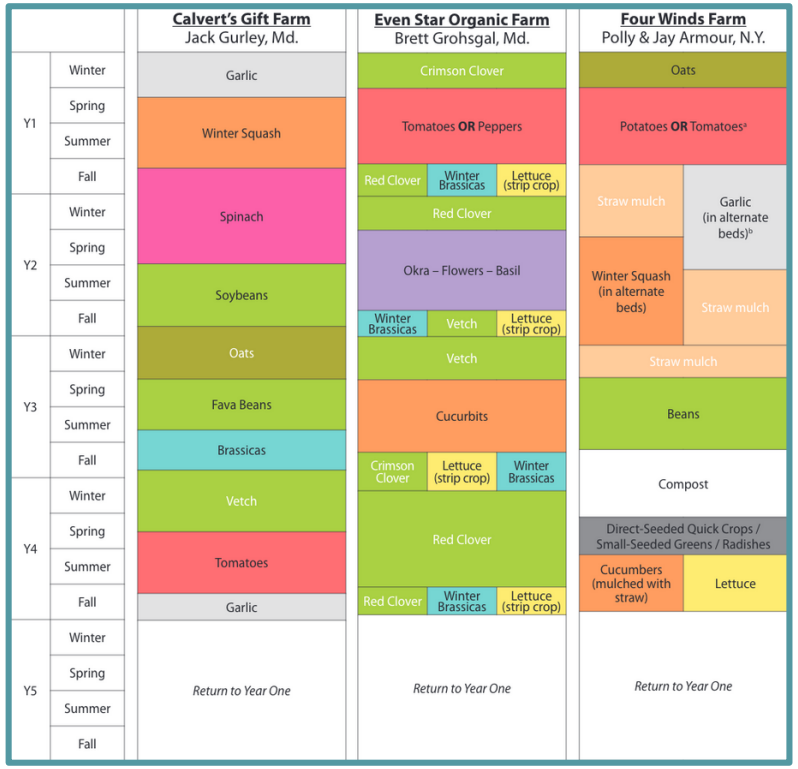
- Many different crops grown that are closely related (lots of brassicas!)
- Climate and management practices dictate what can grow where
- Unexpected and unpredictable weather
- What about perennials?
- Where do cover crops fit in?

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*



Mohler & Johnson (eds) (2009) Crop Rotation on Organic Farms

A Planning Manual. Pg. 49

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?

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- How to crop rotate will depend on your situation
- Plan it out
  - Multiple contingency plans if able

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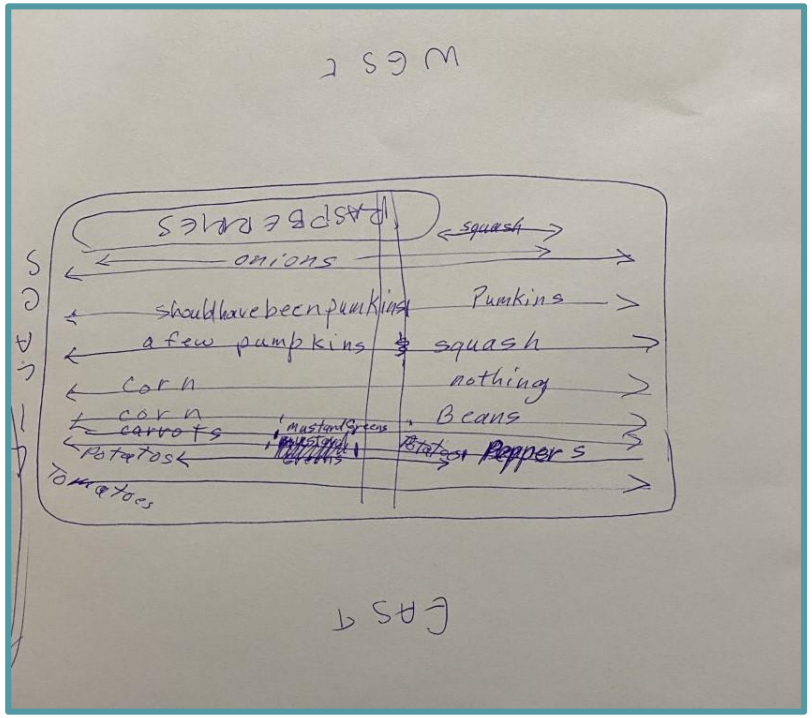
- How to crop rotate will depend on your situation
- Plan it out
- Keep records



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- 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