

Planning for Flexibility in Effective Vegetable Crop Rotations

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Outline

- Introductory comments
- What we learned from the farmers
- Tools for crop rotation planning
- Basics of a planning procedure
- Managing pests and weeds with rotation

Crop rotation defined by NOP

- The practice of alternating the annual crops grown on a specific field in a planned pattern or sequence in successive crop years so that crops of the same species or family are not grown repeatedly without interruption on the same field.

Crop rotation

- Crop rotation is always a good idea
 - Critical for managing disease
 - Nutrients
 - Weeds
 - Building soil quality
 - [Insects]

Crop rotation can be incredibly complicated

- Large variation in acreage among crops
- Some crops are in the ground more than one year
- Multiple plantings of some crops
- Some crops can only be grown on certain fields
- Cover crops between cash crops



NEON: Northeast Organic Network

- Rotation planner project was part of NEON
- Large, 3 year, regional collaborative project funded by USDA.
- Researchers, farmers, farmer organizations, non-profits.

Started by asking expert farmers how they plan crop rotations

- 12 peer nominated exemplary farmers
- Put them in a room for 3 days
- Formal information extraction process
 - DACUM = Develop A CUrriculUM
 - Originally devised for developing training manuals for industry
- The New England Small Farm Institute
 - Sue Ellen Johnson, Eric Toensmeier

The farmers



Bottom line

- None of the 12 farmers develop long term rotation plans
 - Forward planning horizon is 12 to 18 months
- They have a crop mix – amounts of each crop that they want to grow
- They look at each field (bed) history, field characteristics, and place the most appropriate crop on that spot.
- They usually have a plan for the next cover crop and the next cash crop after that

The reason:

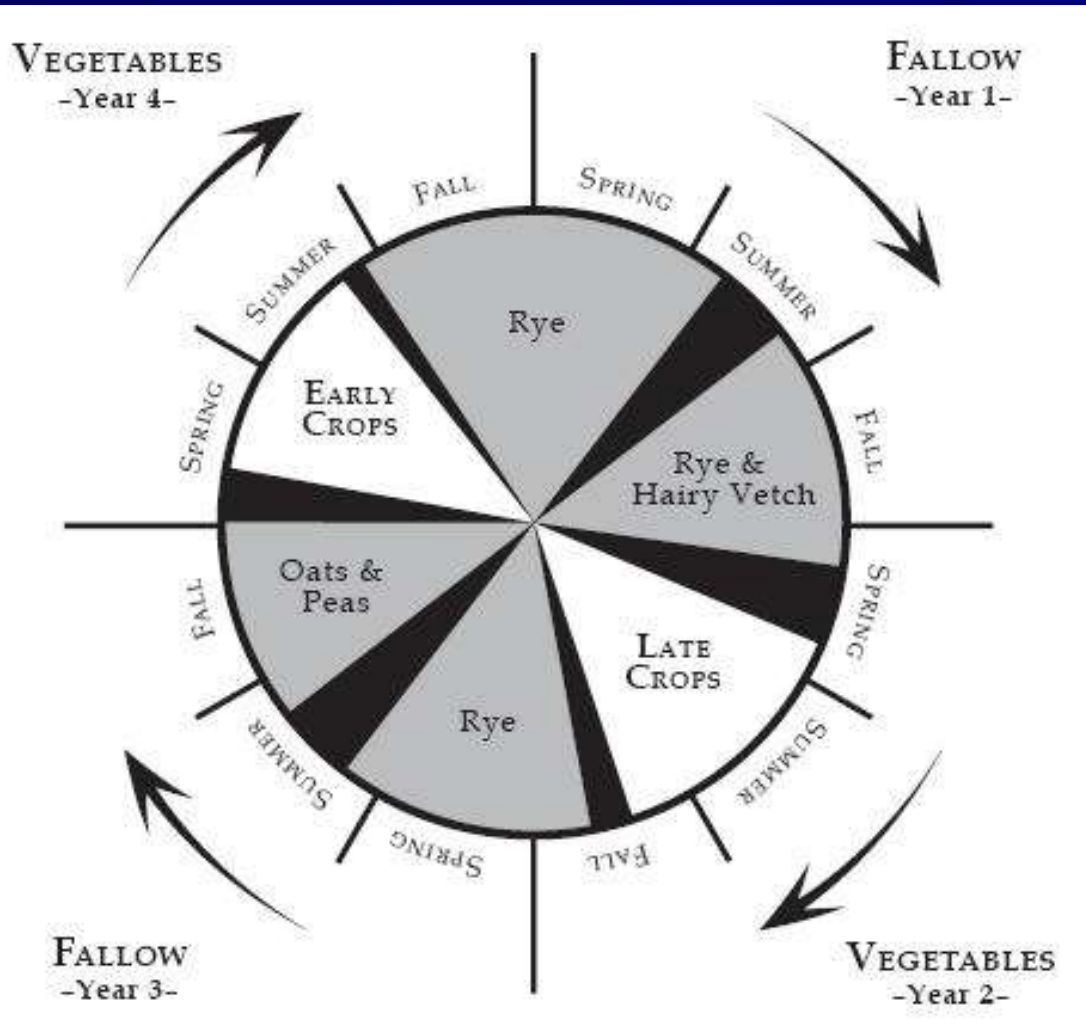
Long-term plans always get derailed

- Weather conditions may delay planting or wipe out a crop and necessitate a substitute crop
- Market conditions change
- Labor supply may not be as expected

However . . .

- Some did their ad hoc placement within the context of a larger scheme
 - Drew Norman: 2-3 years in vegetables, then a 2-3 years in hay

Some other farms studied by NEON used general rotation schemes as well



- Eric and Anne Nordell in N PA
- Have 12 half-acre strips. Sequence repeats 3 times
- *Ad hoc* placement of crops within strips.



Crop Rotation on Organic Farms: a Planning Manual

- **CH 1.** Introduction (CLM)
- **CH 2.** How expert farmers manage crop rotations (SEJ)
- **CH 3.** Biological and physical processes in crop rotation (Various)
- **CH 4.** Example crop rotations (SEJ)
- **CH 5.** A crop rotation planning procedure (CLM)
- **CH 6.** Crop rotation during transition from conventional agriculture (CLM)
- **Ch 7.** Crop rotation and intercropping (CLM and Kim Stoner)
- Reference Tables

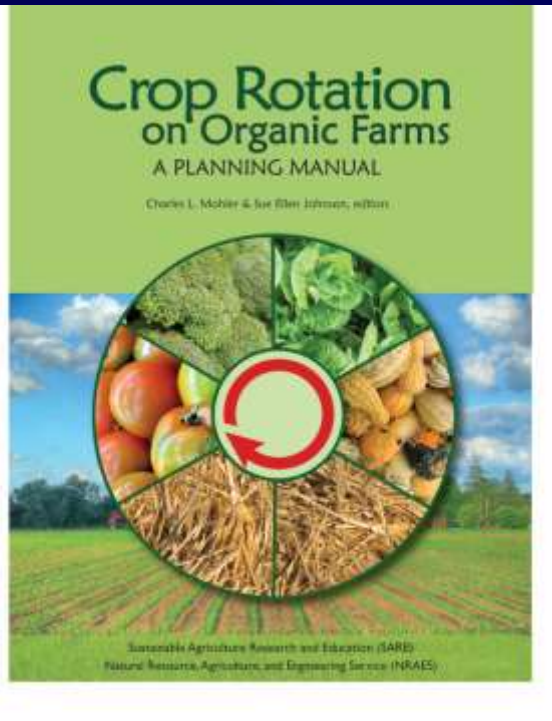
Appendix tables

- Crop characteristics
- Crop sequence problems and opportunities
- Sources of inoculum for crop diseases
- Weed characteristics relevant to crop rotation
- Crop diseases hosted by weeds
- Method for creating a field map in Excel

Following: Preceding:	Pea	Lettuce	Potato	Tomato
Pea	XXXX	D, C-		
Lettuce	D	XXXX	D	D, C-
Potato		D	XXXX	D, I
Tomato		D	D, I	XXXX

■ **D, I, W, C, N, S**

Crop Rotation on Organic Farms: a Planning Manual



- Purchase book:
PALS Publishing
<http://palspublishing.cals.cornell.edu/>
- Free download:
<http://www.sare.org/Learning-Center/Books/Crop-Rotation-on-Organic-Farms>

Planning procedure

- Purpose is not to tell the farmer what to do
- Purpose is
 - to help farmer organize information
 - to make decisions in an orderly series of steps
 - to facilitate checking for problems
- Goal: let anyone develop a plan that is as good as a really smart, experienced grower would produce.

Step 1 – Rotation goals

- Choose rotation goals
- Prioritize goals
 - Avoid soil-borne disease
 - Grow N-fixing cover crops
 - Suppress weeds

Step 2 – Do I want a general plan?

“Simple” operation

Rest years

**Low variation in
acreage among crops**

Few crops

One cash crop/year

**Minor variation in soils,
topography etc.**

Focus on a general plan

“Complex” operation

Continuous cropping

**High variation in
acreage among crops**

Many crops

Multiple cropping

**Much variation in soils
topography etc.**

**Focus on crop
sequencing**



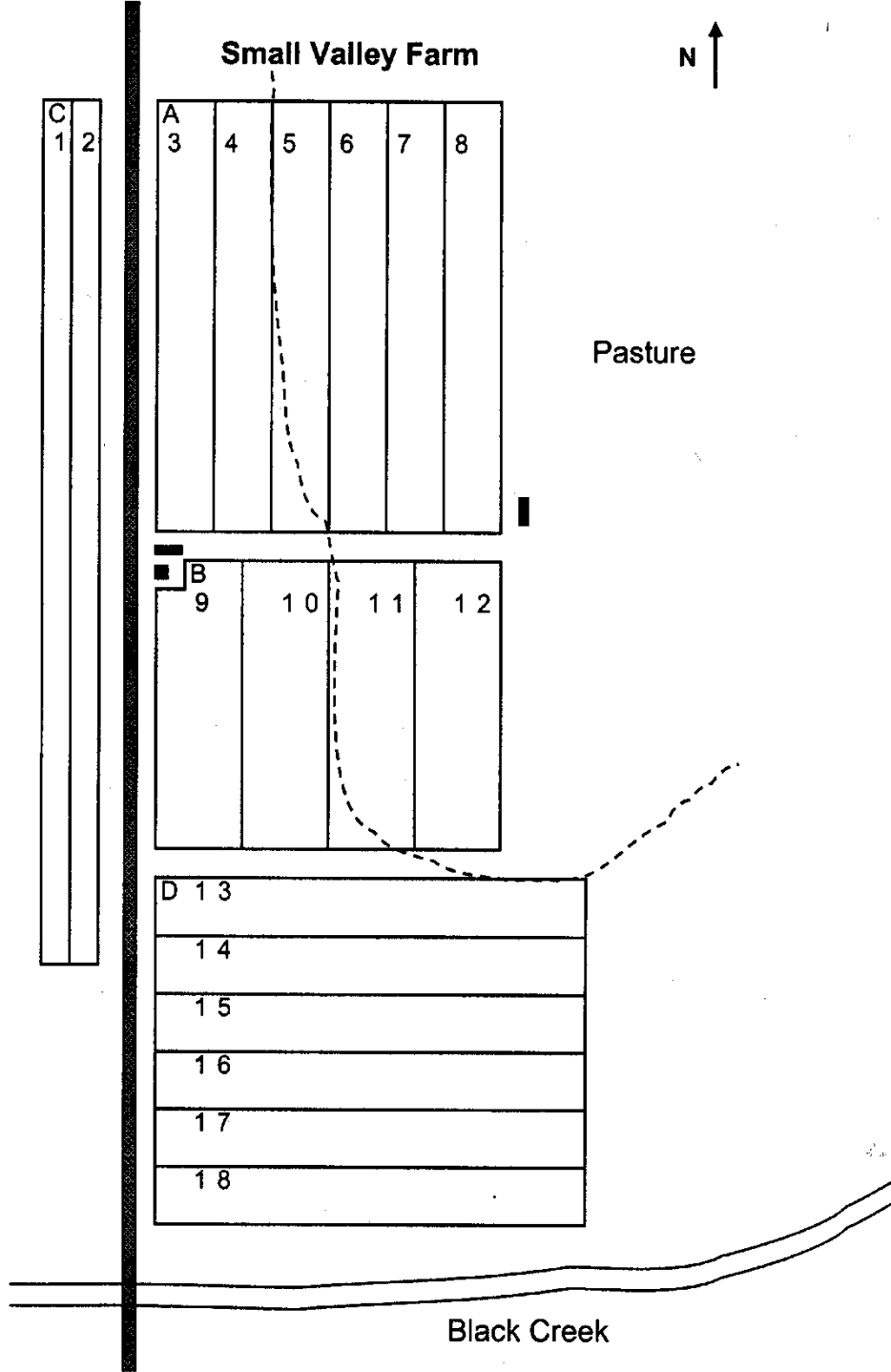
Write down the crop mix

Crop	Acres
Turnips	20
Beets	10
Carrots	30
Peas	20
Broccoli	20

Check family return times

Onion	3	Lilly
Potato	5	Nightsh.
Tomato	3	Nightsh.
Lettuce	6	Aster
Pepper	2	Nightsh.
W. squash	4	Cucurb.
S. squash	4	Cucurb.
Brassicas	6	Brassica
Total	30	

- Nightshades have 10 A out of 30 A in production.
- $30/10 = 3$
- On average, a field will have a nightshade one year out of every 3 years
- Disease risk!
- Try for return times of at least 4 years for all families (**except grasses**)



Make a crop rotation planning map

- Equal area planning units
- Identify characteristics of each unit

Make a table

- For each management unit:
 - List **critical** characteristics
 - Crops for last 3 years

Example planning table

MU	Char	Three summers ago	Two winters ago	Two summers ago	Last winter	Last summer
9	early	Kohlrabi/ buckwheat	Oat	Pea/ Sorgh-sud	Oat	Carrot
10	early	Beet 5/ buckwheat	Oat	Pea/ Sorgh-sud	Oat	Carrot
11		Pepper	Oat	S. Squash	Oat	Pea/ Sorgh-sud
12		Pepper	Oat	S. Squash	Oat	Pea/ Sorgh-sud

Sort the management units

- 1, put MU' s with similar *critical* field conditions together
- 2, put MU' s with similar histories together

Plan future crop sequences – write crops onto the planning sheet

■ Next summer

- Cash crops already in the ground
- Families that are close to the maximum allowable return time
- High value crops that require special field conditions
- Other valuable crops that grow anywhere
- Less valuable crops that require special conditions
- Less valuable crops that grow anywhere

2006

Section 1

Section 2



	5.8 bu/bed					44.8 bu	
1st Peas							
1st Peas							
1st Peas							
1st Peas							
2nd Peas							
2nd Peas							
2nd Peas							
2nd Peas							

	5.8 bu/bed					44.8 bu	
Chard							
Scallion 1							
Chard 2							
Scallion 2							
3rd Peas							
3rd Peas							
3rd Peas							
3rd Peas							





Sample mapping in Excel

[Map](#)

SECTION	BED	CURRENT PLANTING	DATE	SECOND PLANTING	DATE	COVER CROP	DATE
1	1	1st Peas	26-Mar	Lettuce 15	23-Jul	none	
6 bedunits	2	1st Peas	26-Mar	Lettuce 15	23-Jul	none	
Total 48	3	1st Peas	26-Mar	Dill, Cilantro 16	30-Jul	none	
	4	1st Peas	26-Mar	Lettuce 17	6-Aug	none	
	5	2nd Peas	2-Apr	Lettuce 17	6-Aug	none	
	6	2nd Peas	2-Apr	Lettuce 16	30-Jul	none	
	7	2nd Peas	2-Apr	Lettuce 16	30-Jul	none	
	8	2nd Peas	2-Apr	Spinach 16, 17	30-Jul	none	
SECTION	BED	CURRENT PLANTING	DATE	SECOND PLANTING	DATE	COVER CROP	DATE
2	1	Chard	9-Apr	Spinach 21	3-Sep	none	
6 bedunits	2	Scallion 1	9-Apr	Spinach 21	3-Sep	none	
Total 48	3	Chard 2	23-Apr	Lettuce 21	3-Sep	none	
	4	Scallion 2	23-Apr	Lettuce 21	3-Sep	none	
	5	3rd Peas	9-Apr	Lettuce 21	3-Sep	none	
	6	3rd Peas	9-Apr	Lettuce 20	27-Aug	none	
	7	3rd Peas	9-Apr	Lettuce 20	27-Aug	none	
	8	3rd Peas	9-Apr	Lettuce 20	27-Aug	none	

Future years

- Check next summer's crop, mix
- Plan two summers from now
- Now go back and fill in cover crops between next summer and 2 summers from now

Put plans on maps and walk

- Put the plans on maps, one map per year
- Take the maps to the field – take notes
 - “Farm the land in your head”
- What could go wrong?
 - Note contingency plans !

An ecological perspective on rotation and pest management

- Annual crops
 - First year of ecological succession
 - Crop is at outbreak density & abundance
- Annual plants in nature escape by being unpredictable in space and time
- If we grow the same species repeatedly, in a field
 - then it isn't unpredictable
 - And it gets hammered
- Meanwhile weeds are moving in to drive succession forward

Rotation can't solve all problems

Pest	agent	Rotation	Notes
Tomato bacterial spot	<i>Xanthomonas campestris</i> pv. <i>vesicatoria</i>	Y (1-3)	seed borne
Club root	<i>Plasmodiophora brassicae</i>	Y (7)	weeds
Damping off	<i>Pythium</i> spp.	N	saprobe
Late blight	<i>Phytophthora infestans</i>	N	wind blown
Corn root worm	<i>Diabrotica</i> spp.	Y	life cycle
Imported cabbageworm	<i>Pieris rapae</i>	N	good flyer

Crop rotation for weed control

- Multi-year tactics.
- Often involves manipulation of the weed seed bank.
- Requires integration with tillage practices.

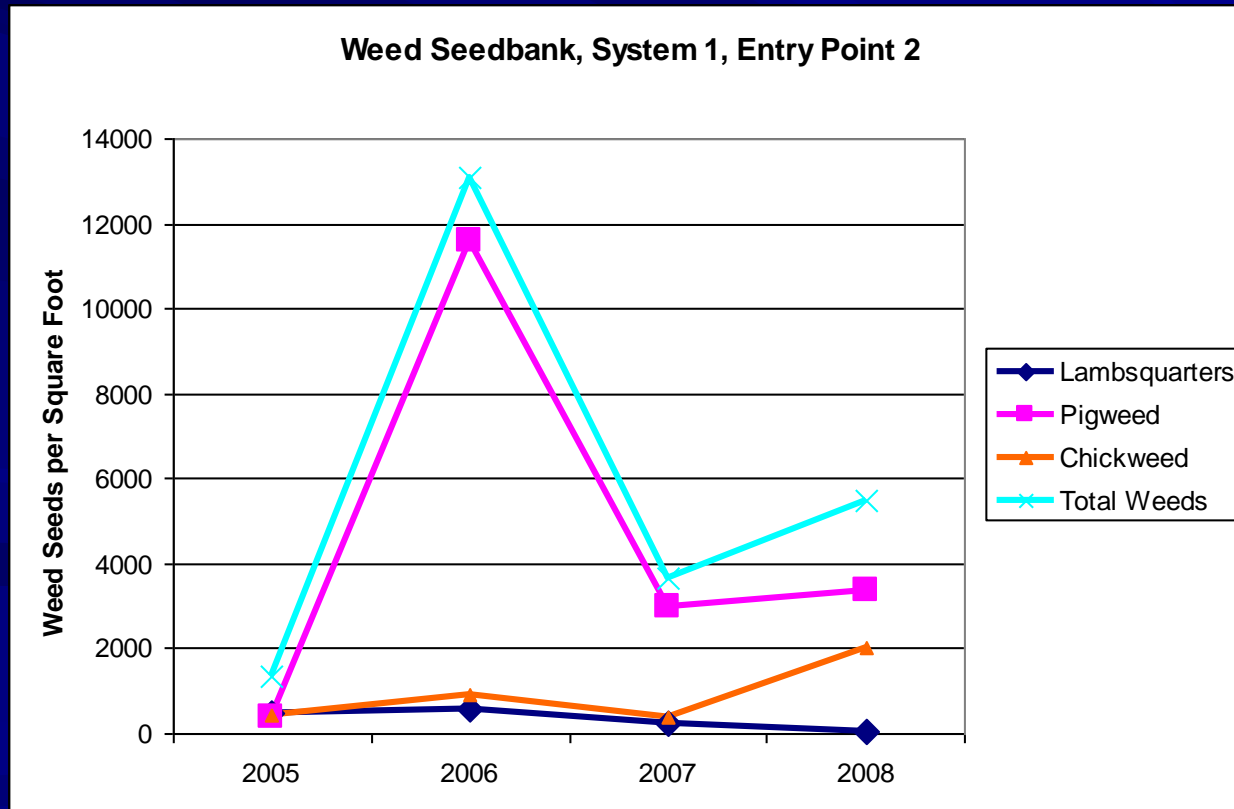
Tilled fallow



- Tillage promotes weed seed germination.
 - Firm seed bed
- Then shallowly till again to kill weeds
- Repeat.
- Plant

Follow weedy crops with crops that are easy to keep weeded

- This allows depletion of the seed bank built up in the previous year



Rotate between crops with different seasonality

Early summer planted



**Spring
planted**



**Mid-summer
planted**



Work cover crops into the rotation

- Sow heavy for best weed suppression.
- Winter cover can suppress quackgrass



Rye and hairy vetch

Avoid cover crops that cause weed problems

- Example: hairy vetch can be a bad weed in wheat.

Rotate annuals with sod crops

- Repeated mowing depletes perennial weeds
- Annuals can't reproduce so seed bank declines



Conclusions – lots of aspects to good rotation planning

- Several ways to use the book
- Reference
 - Basic principles and concepts of crop rotation
 - Look up information
- Inspiration – what do other farmers do
- Systematic planning too

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