East National Technology Support Center

Conservation Planning for Diverse Vegetable Rotations: Tools and Issues

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Agronomist

Topics to Cover

- 1. Basics of Rotations
- 2. Development of Farmer Rotations
- 3. Steps of Conservation Planning
- 4. Tools & Resources

Why Rotate Crops?

- Farmers design their rotations to:
  - Earn income
  - Increase soil health or build “soil capital”
- Numerous books and articles outline the goals and benefits of crop rotations:

Why Rotate Crops?

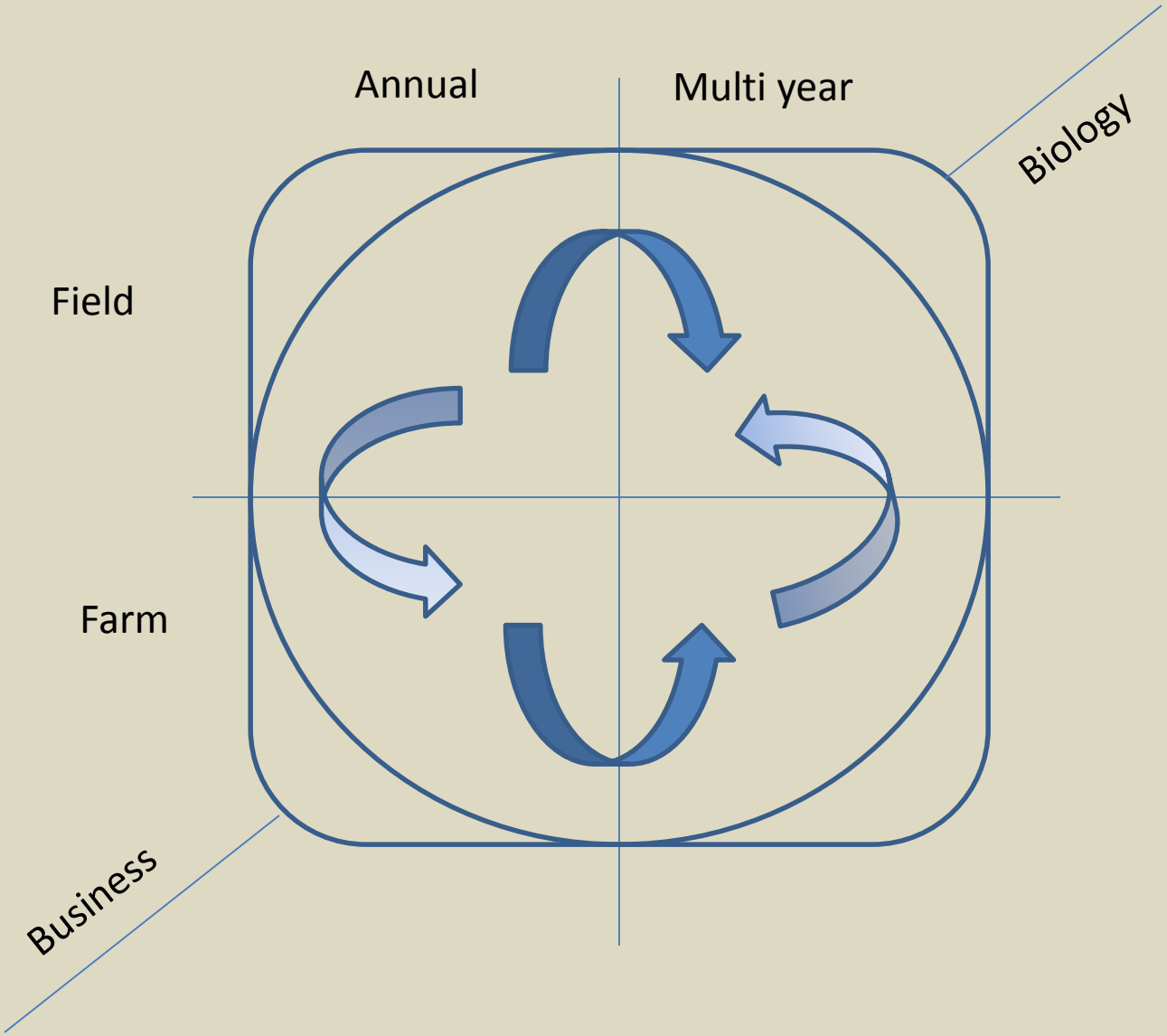
- Cyclopedia of American Agriculture (1907)
  - Rotation must adapt itself to the farmer's business
  - Adapt itself to the soil and fertility problems
  - Fertilizer question often modifies the rotation
  - Kind of soil and climate may dictate the rotation
  - Labor supply has an important bearing on the character of the rotation
  - Size of farm and use of land in pasture

Why Rotate Crops?

- Organic Farming (1990) – chapter 5, “Rotation Design for Organic Systems”
  - Basic guidelines:
    - Deep rooting crops should follow shallow rooting crops
    - Alternate between crops with high and low root biomass
    - Nitrogen fixing crops should alternate with nitrogen demanding crops
    - Catch crops, green manures, and undersowing techniques should be used to keep the soil covered.

Crop Rotation and Farm Management

- Multidimensional thinking is needed in developing intensive vegetable rotations.
- Rotation management requires an understanding of both the whole farm and each individual field.
- Balance of field and farm-scale decisions.
- Rotation planning is a rolling, responsive process.


Annual
Multi year
Biology
Field
Farm
Business

Crop Rotation and Farm Management

- Farmers are continually balancing annual and multiyear (short and long-term) decisions.
- Business decisions must be optimized for annual returns and cash flow.
- In any given season, market opportunities and logistical needs may override biological concerns.

Crop Rotation and Farm Management

- Farms have a few key cash crops to generate income.
- Farmers focus on planting their key crops on the most suitable fields for those crops without compromising the soil health and long-term productivity of those fields.
- Crop to field matches are first made based on market and logistical considerations.

Crop Rotation and Farm Management

- Unexpected opportunities and circumstances often confront farmers
  - Market opportunity or logistical contingency
  - Assess the feasibility to determine if a market can be met successfully.
  - Biological cross-check to determine the field or variety.
  - Biological “rules” may be stretched to meet the market, but they are not repeatedly ignored on the same fields.

Crop Rotation and Farm Management

- Design crop rotations to set up for future key crops
- A rotation can be designed so that substantial spring growth of an overwintering cover crop precedes a heavy-feeding cash crop.
- Plans don’t always go as expected.

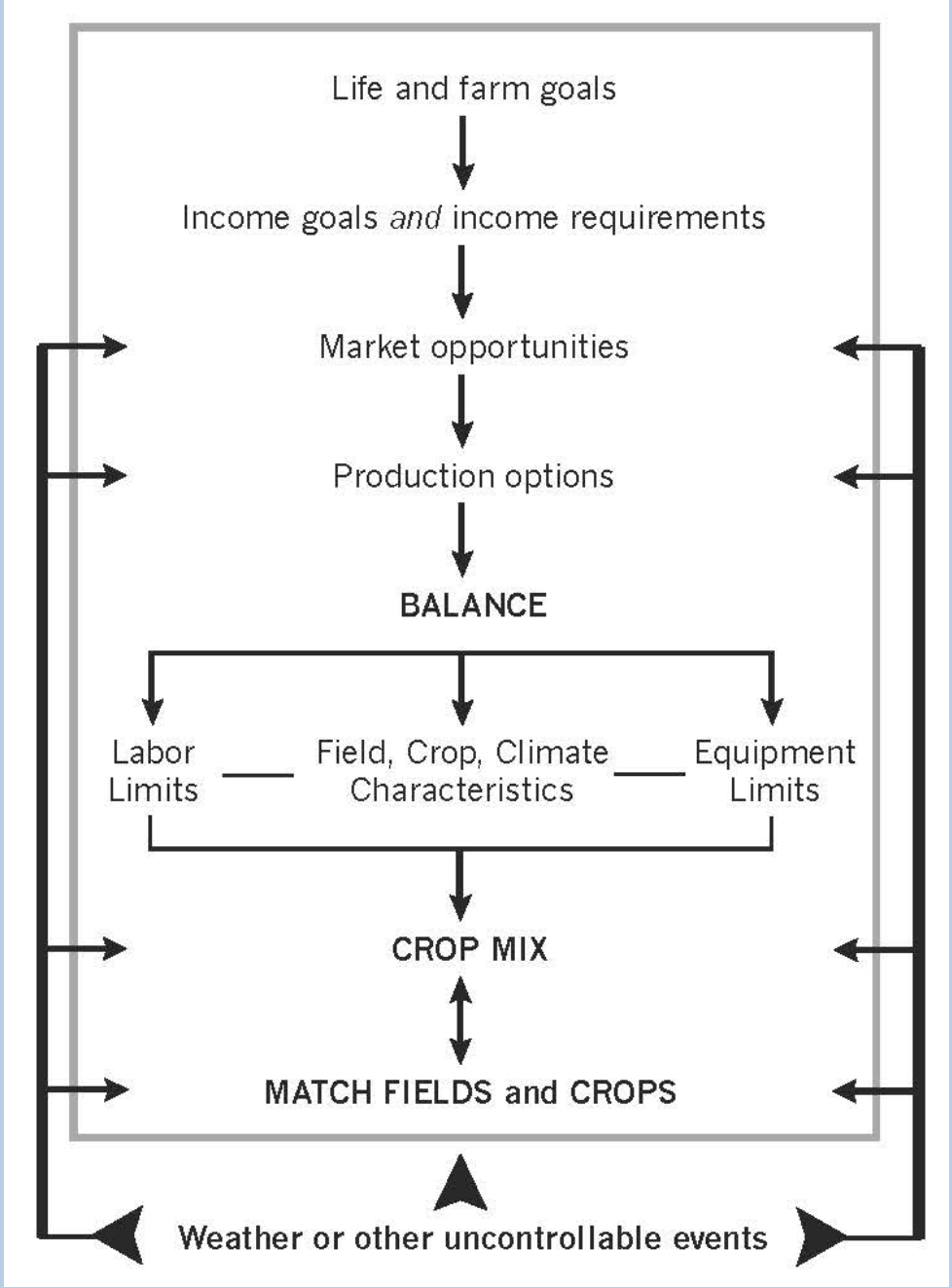
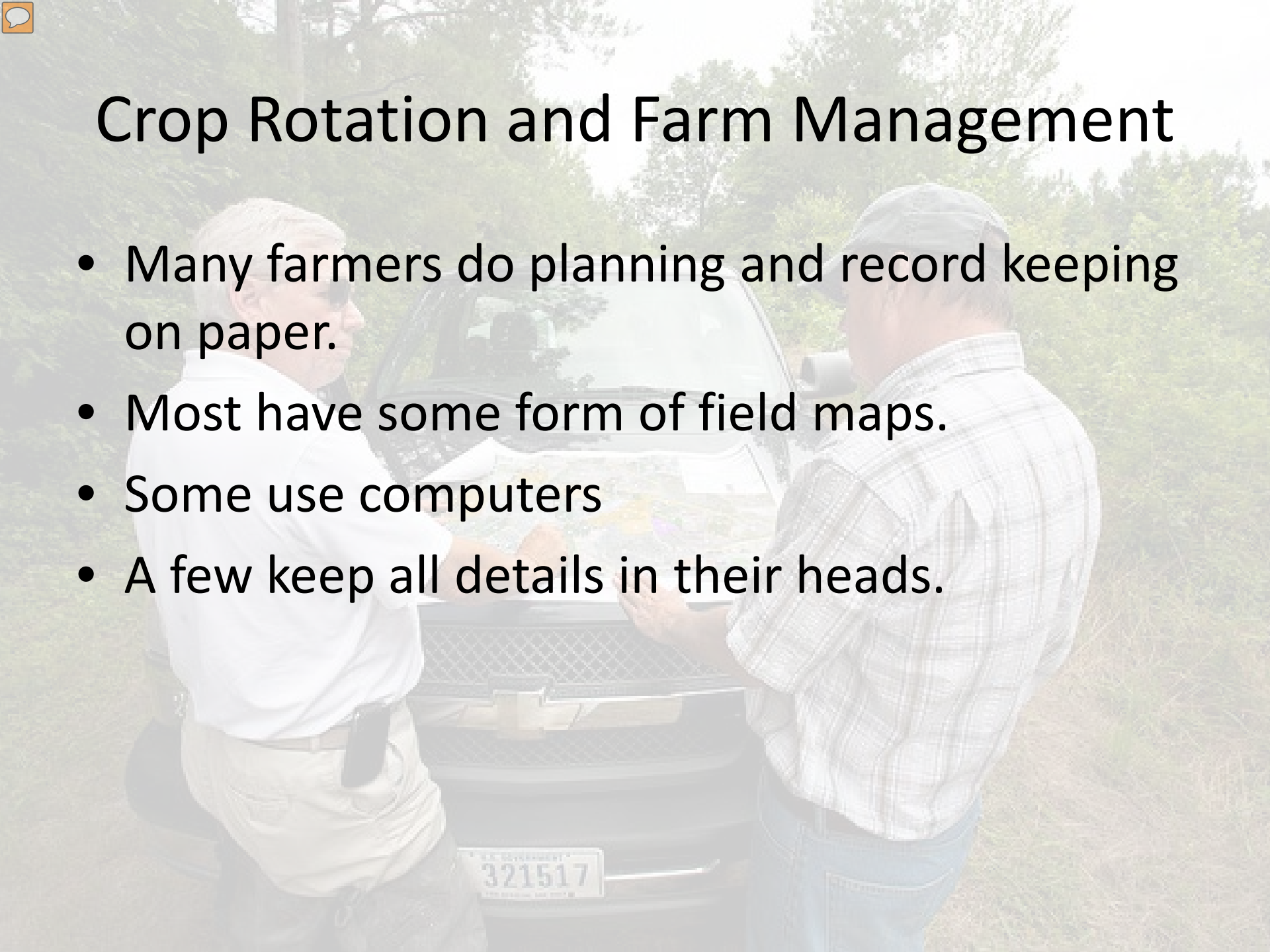


Image from: Crop Rotation on Organic Farms: A Planning Manual, NRAES 177

Crop Rotation and Farm Management



- Many farmers do planning and record keeping on paper.
- Most have some form of field maps.
- Some use computers
- A few keep all details in their heads.

General Rotation Principles

- Follow a legume forage crop, such as clover or alfalfa, with a high nitrogen-demanding crop, such as corn, to take advantage of the nitrogen.
- Grow less nitrogen-demanding crops, such as oats, barley, or wheat, in the second or third year after a legume sod.
- Grow the same annual crop for only one year, if possible, to decrease the likelihood of insects, disease, and nematodes becoming a problem.

General Rotation Principles

- Don’t follow one crop with another closely related species, since insect, disease, and nematode problems are frequently shared by members of closely related crops.
- Use crop sequences that promote healthier crops.
- Use crop sequences that aid in controlling weeds.

General Rotation Principles

- Use longer periods of perennial crops, such as a forage legume, on sloping land and on highly erosive soils.
- Try to grow a deep-rooted crop, such as alfalfa, safflower, or sunflower, as part of the rotation.
- Grow some crops that will leave a significant amount of residue, like sorghum or corn harvested for grain, to help maintain organic matter levels.

General Rotation Principles

- When growing a wide mix of crops – as is done on many direct-marketing vegetable farms – try grouping into blocks according to plant family, timing of crops (all early-season crops together, for example), type of crop (root vs. fruit vs. leaf), or cultural practices (irrigated, plastic mulch used).

General Rotation Principles

- In regions with limited rainfall, the amount of water used by a crop may be a critically important issue – usually one of the most important issues.
- Be flexible enough to adapt to annual climate and crop price variations, as well as development of soil pathogens and plant parasitic nematodes.

Farmer Responsibilities and Related Conservation Planning Steps

Farmer Responsibilities

- Identify Rotation Goals
- Identify Resources and Constraints
- Gather Data
- Analyze Data
- Plan Crop Rotation
- Execute Rotation
- Evaluate Rotation Execution
- Adjust Rotation Plan

Planning Steps

- Identify Problems & Opportunities
- Determine Objectives
- Inventory Resources
- Analyze Resource Data
- Formulate Alternatives
- Evaluate Alternatives
- Make Decisions
- Implement the Plan
- Evaluate the Plan

Farmer Responsibilities

- Identify Rotation Goals
  - Rotations are a means to meet overall farm goals
  - Farmers manage their field rotations in the context of their whole farm systems.
  - Most important and difficult task is reviewing the overall farm operation.
  - Review the production plan: the crops, cover crops, fallows, and livestock that need to be allocated to particular field areas in the coming year.

Farmer Responsibilities

- Identify Rotation Goals
  - Factors including cropland available, equipment, cash flow, crop mix, and marketing strategies. These all define the parameters within which the rotation must be designed.
  - Identify which problems can be addressed by the rotation.

Farmer Responsibilities

- Identify Resources and Constraints
  - Identifying the possibilities and limits of the overall farm production plan and the rotation for each field is central to planning.
  - Parameters such as market demand, available land, equipment, projected labor availability, and regulatory issues.

Farmer Responsibilities

- Identify Resources and Constraints
  - Constraints may include field-specific limits like whether a field is ready for planting and harvest early or late in the season and how that relates to market timing, cash flow, and profitability.
  - Constraints imposed by equipment, such as row width, must be figured into the rotation plan.

Farmer Responsibilities

- Gather Data
  - Rotation decisions, for each field and for the whole farm are based on an array of information.
  - Information is collected on the farm, and some is gathered from off-farm sources.
  - Observing crops and fields is an important task.
  - Update production and marketing information
  - Categorization of crops and fields helps guide the optimal allocation of particular crops to individual fields or beds each year.

Farmer Responsibilities

- Analyze Data
  - All of the decisions and information generated through previous tasks and responsibilities are pulled together for analysis at this key phase of the planning process.
  - Data on market options, equipment, labor and seed availability, and financial constraints, along with the overall farm and rotation goals are reviewed.
  - Crop cultural needs are compared to each field's characteristics and conditions.

Farmer Responsibilities

- Plan the crop rotation
  - This responsibility is the ultimate synthesis of information and results in a production plan and a rotation plan.
  - Farmers distinguish between these two types of plans.
    - Production plan
    - Rotation plan

Farmer Responsibilities

- Two questions bounce back and forth.
  - What will be grown in each field?
  - Where will each crop grow?
- These questions are answered based on observation and experience.
- Several steps are involved.
  - First, the cropping history of each field or bed for the past three or more years is reviewed.

Farmer Responsibilities

- Steps (cont)
  - The allocation of crops to fields includes consideration of future cropping plans as well as the cropping history of a field.
  - The rotation plan must be responsive to weed pressures or other legacies from earlier years and must provide future crops with favorable conditions.

Farmer Responsibilities

- Farmers first assign their highest-priority crops to fields (or beds).
- High-priority crops include the most profitable crops, cover crops with the greatest benefits, and crops particularly vulnerable to pests, diseases, or weather.
- Remaining fields (or parts of fields) are then assigned to the remaining crops, cover crops, fallow areas, and sometimes pasture for livestock.
- All these decisions are based on both business and biology.

Farmer Responsibilities

- The crops and fields are tentatively matched, creating a cropping plan for the entire farm for the year.
- They take this initial plan and, in the words of one, “Farm it in my head.”
- That is, they work through the sequence of field operations from tillage to harvest over the entire season for each crop and field.

Farmer Responsibilities

- Execute Rotation
  - Farmers indicated that executing the rotation involves many of the most important and difficult tasks.
  - They identified maintaining crops (including activities such as weeding, thinning, and irrigation) as the most important task and the second most difficult task in crop rotation.
  - Scheduling tillage and planting for all the fields across an entire farm every season is also a challenge for most farmers.

Farmer Responsibilities

- Execute Rotation
  - Other critical steps in crop production and central to executing the crop rotation are soil preparation and planting.
  - Delays in soil preparation or planting may cause crop failures due to poor emergence, runaway weeds, or inadequately broken down cover crops and require shifts in the crop rotation.

Farmer Responsibilities

- Execute Rotation
  - Farmers attempt to plant priority fields or beds and their most important crops as scheduled in their plan.
  - If they have to alter the plan, they still prioritize high-value or sensitive crops and fields. Many decisions and adjustments have to be made on the fly.

Farmer Responsibilities

- Execute Rotation
  - In early spring, farmers monitor the weather—sometimes hourly—as they implement and alter their rotation plan.
  - Problems related to weather, cover crop maturity, crop emergence, and weeds may cause farmers to alter their original plan.
  - While a change necessitated by weather or the conditions in one field can cause reassignment of crops around the farm, general and farm-specific rotation goals and guidelines remain the basis of every decision.

Farmer Responsibilities

- Evaluate Rotation Execution
  - Throughout the season, growers monitor the performance of their fields, each crop, and the farm as a whole.
  - They record how their plans have worked and evolved. This is not just to solve problems in the current season, but also to observe, learn, and collect ideas and data for future seasons.

Farmer Responsibilities

- Evaluate Rotation Execution
  - At the end of the season, growers carefully assess what actually happened relative to what they expected based on the original rotation plan.
  - The factors they consider include yields; soil conditions; timing of events and operations; costs of crop production; disease, weed, and pest levels and their control; crop losses; labor satisfaction and efficiency; and profitability of each crop and of the whole farm.

Farmer Responsibilities

- Evaluate Rotation Execution
  - Rotation goals and rotation plans serve as benchmarks to measure the success of the cropping season and the rotation.
  - Successes and failures are assessed, analyzed, and evaluated.
  - The results are recorded to assist in planning and management for future seasons.

Farmer Responsibilities

- Adjust Rotation Plan
  - As the cropping season closes in late fall, farmers begin the final phase of the annual rotation cycle in which they modify their rotations and plan for the coming year.
  - They revisit the tasks associated with “Identify rotation goals”
  - They then focus on the productivity and problems of each field and of the overall farm.

Farmer Responsibilities

- Adjust Rotation Plan
  - They first consider altering the crop mix by adding or removing crops or changing the area planted to a crop.
  - Growers may also decide to change their field management by changing the order or dates of planting or plowdown of cover crops.
  - They may decide to shift crops to alternative fields, try new crop sequences, or improve fertility of a field by planting it into a cover crop or hay ahead of schedule.

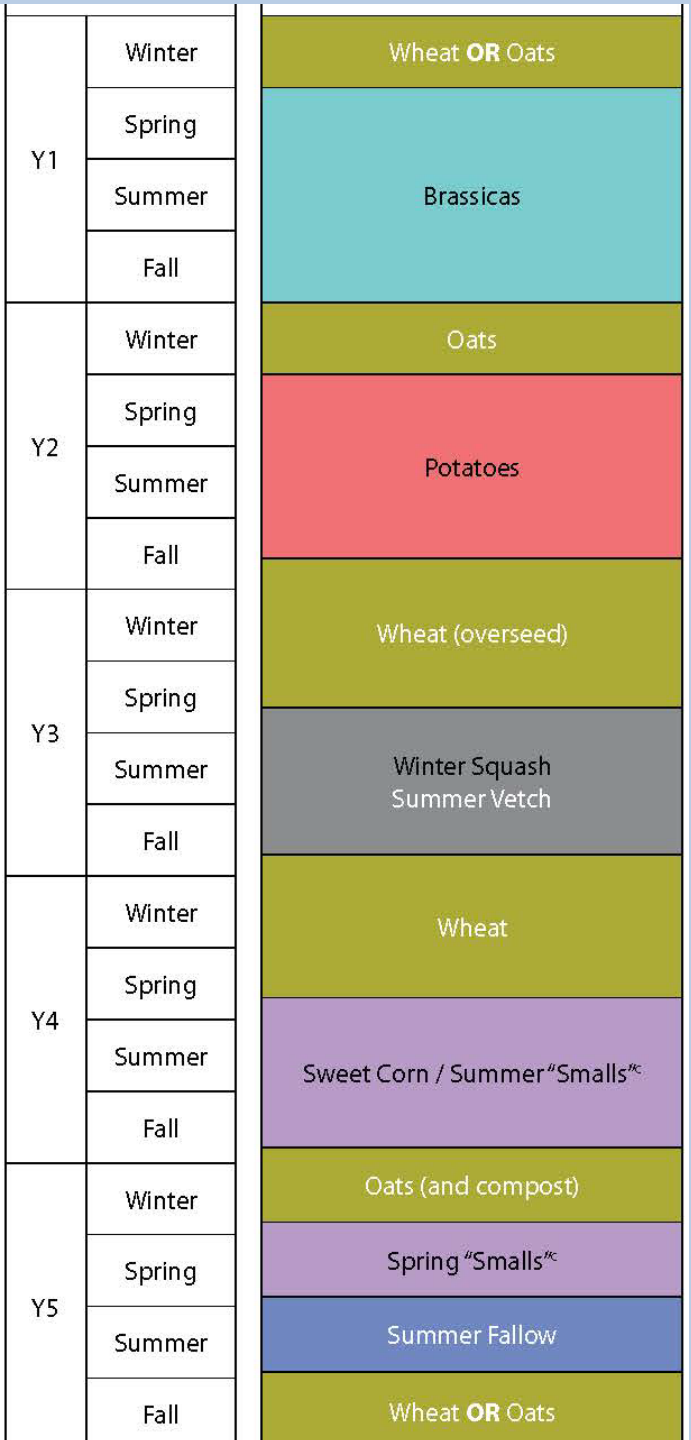
Farmer Responsibilities

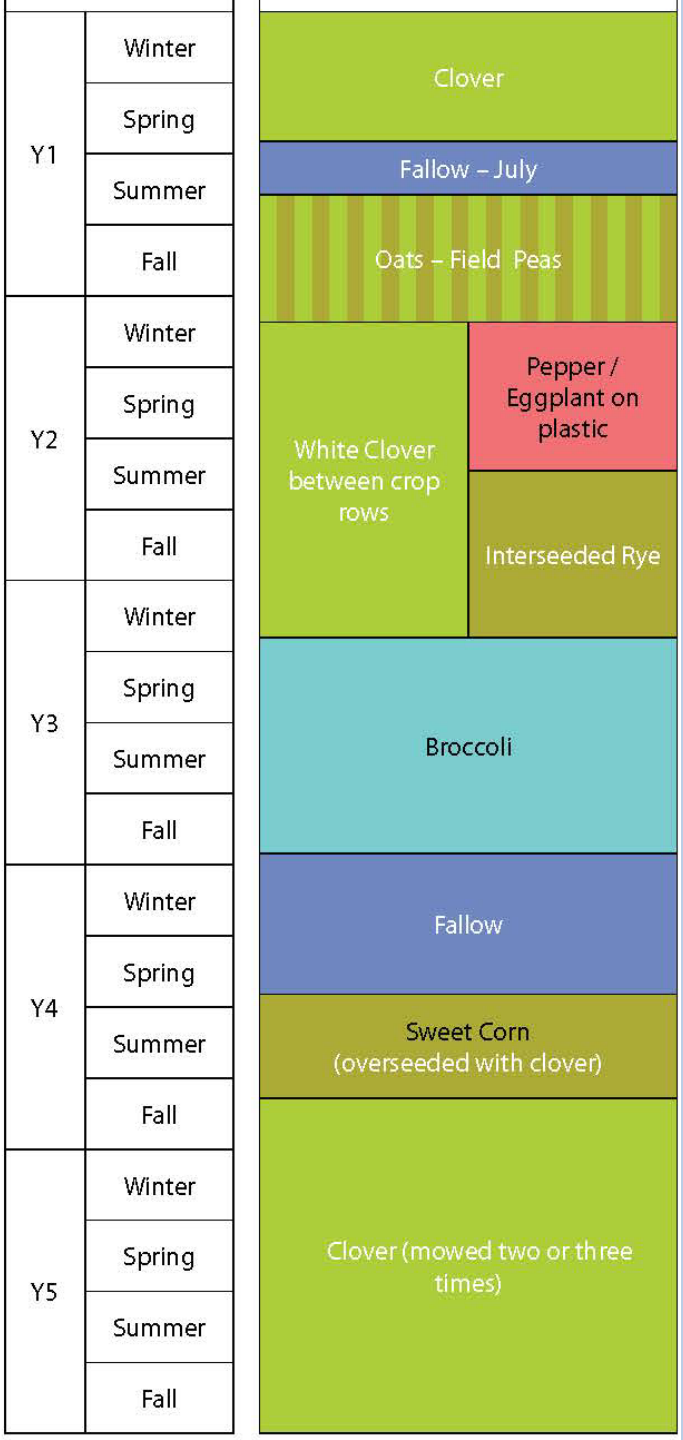
- Adjust Rotation Plan
  - Adjusting the rotation plan presents three particularly challenging tasks:
    - (1) developing collaborations to solve problems,
    - (2) investigating markets, and
    - (3) tweaking the crop mix.
- Farmers stress the importance of experimentation, play, and a sense of adventure in managing their rotations.

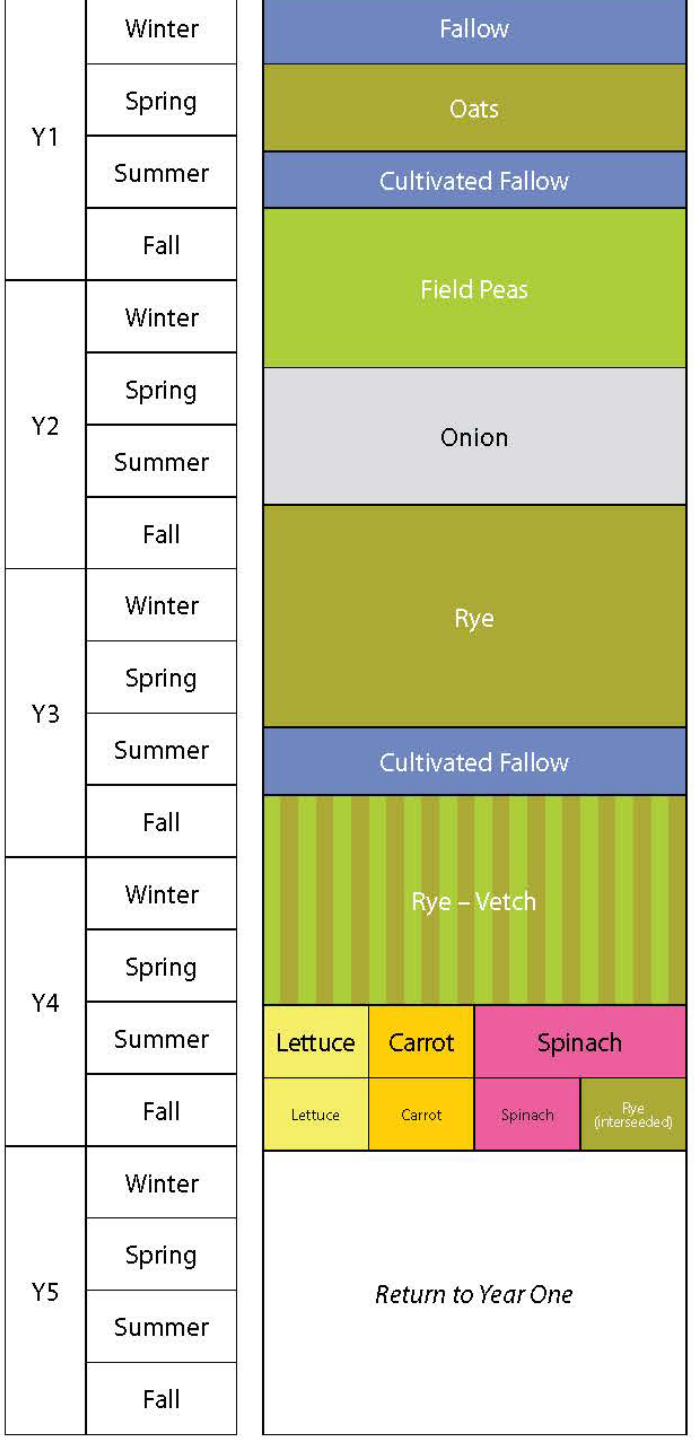
Y1	Winter	Garlic
	Spring	Winter Squash
	Summer	
	Fall	
Y2	Winter	Spinach
	Spring	
	Summer	Soybeans
	Fall	
Y3	Winter	Oats
	Spring	Fava Beans
	Summer	
	Fall	Brassicas
Y4	Winter	Vetch
	Spring	
	Summer	Tomatoes
	Fall	Garlic
Y5	Winter	*Return to Year One*
	Spring	
	Summer	
	Fall	

Y1	Winter	Crimson Clover		
	Spring	Tomatoes **OR** Peppers		
	Summer			
	Fall	Red Clover	Winter Brassicas	Lettuce (strip crop)
Y2	Winter	Red Clover		
	Spring	Okra – Flowers – Basil		
	Summer			
	Fall	Winter Brassicas	Vetch	Lettuce (strip crop)
Y3	Winter	Vetch		
	Spring	Cucurbits		
	Summer			
	Fall	Crimson Clover	Lettuce (strip crop)	Winter Brassicas
Y4	Winter	Red Clover		
	Spring			
	Summer			
	Fall	Red Clover	Winter Brassicas	Lettuce (strip crop)
Y5	Winter	*Return to Year One*		
	Spring			
	Summer			
	Fall			

Y1	Winter	Oats	
	Spring	Potatoes **OR** Tomatoes[a]	
	Summer		
	Fall		
Y2	Winter	Straw mulch	Garlic (in alternate beds)[b]
	Spring	Winter Squash (in alternate beds)	
	Summer		Straw mulch
	Fall		
Y3	Winter	Straw mulch	
	Spring	Beans	
	Summer		
	Fall	Compost	
Y4	Winter		
	Spring	Direct-Seeded Quick Crops / Small-Seeded Greens / Radishes	
	Summer	Cucumbers (mulched with straw)	Lettuce
	Fall		
Y5	Winter	*Return to Year One*	
	Spring		
	Summer		
	Fall		


Y1
Winter
Spring
Summer
Fall
Wheat OR Oats
Brassicas
Y2
Winter
Spring
Summer
Fall
Oats
Potatoes
Y3
Winter
Spring
Summer
Fall
Wheat (overseed)
Winter Squash
Summer Vetch
Y4
Winter
Spring
Summer
Fall
Wheat
Sweet Corn / Summer "Smalls"
Y5
Winter
Spring
Summer
Fall
Oats (and compost)
Spring "Smalls"
Summer Fallow
Wheat OR Oats


Y1
Winter
Spring
Summer
Fall
Y2
Winter
Spring
Summer
Fall
Y3
Winter
Spring
Summer
Fall
Y4
Winter
Spring
Summer
Fall
Y5
Winter
Spring
Summer
Fall
Clover
Fallow – July
Oats – Field Peas
White Clover between crop rows
Pepper / Eggplant on plastic
Interseeded Rye
Broccoli
Fallow
Sweet Corn (overseeded with clover)
Clover (mowed two or three times)


Y1
Winter
Spring
Summer
Fall
Fallow
Oats
Cultivated Fallow
Y2
Winter
Spring
Summer
Fall
Field Peas
Onion
Y3
Winter
Spring
Summer
Fall
Rye
Cultivated Fallow
Y4
Winter
Spring
Summer
Fall
Rye – Vetch
Lettuce
Carrot
Spinach
Lettuce
Carrot
Spinach
Rye (interseeded)
Y5
Winter
Spring
Summer
Fall
Return to Year One

Conservation Planning Steps

- Identify Problems and Opportunities
  - Identify existing resource problems and concerns and potential opportunities in the planning area.
- Determine Objectives
  - Identify and document the client's objectives.

Conservation Planning Steps

- Inventory Resources
  - Inventory and document the natural resources and their current onsite and offsite conditions and effects, as well as the economic and social considerations related to the resources.

Conservation Planning Steps

- Analyze Resource Data
  - Analyze the resource information gathered in the inventory resources step.
  - Define the existing natural resource conditions, along with economic and social issues related to the resources.
  - Information from this step will help to further define and clarify problems, concerns, and opportunities.

Conservation Planning Steps

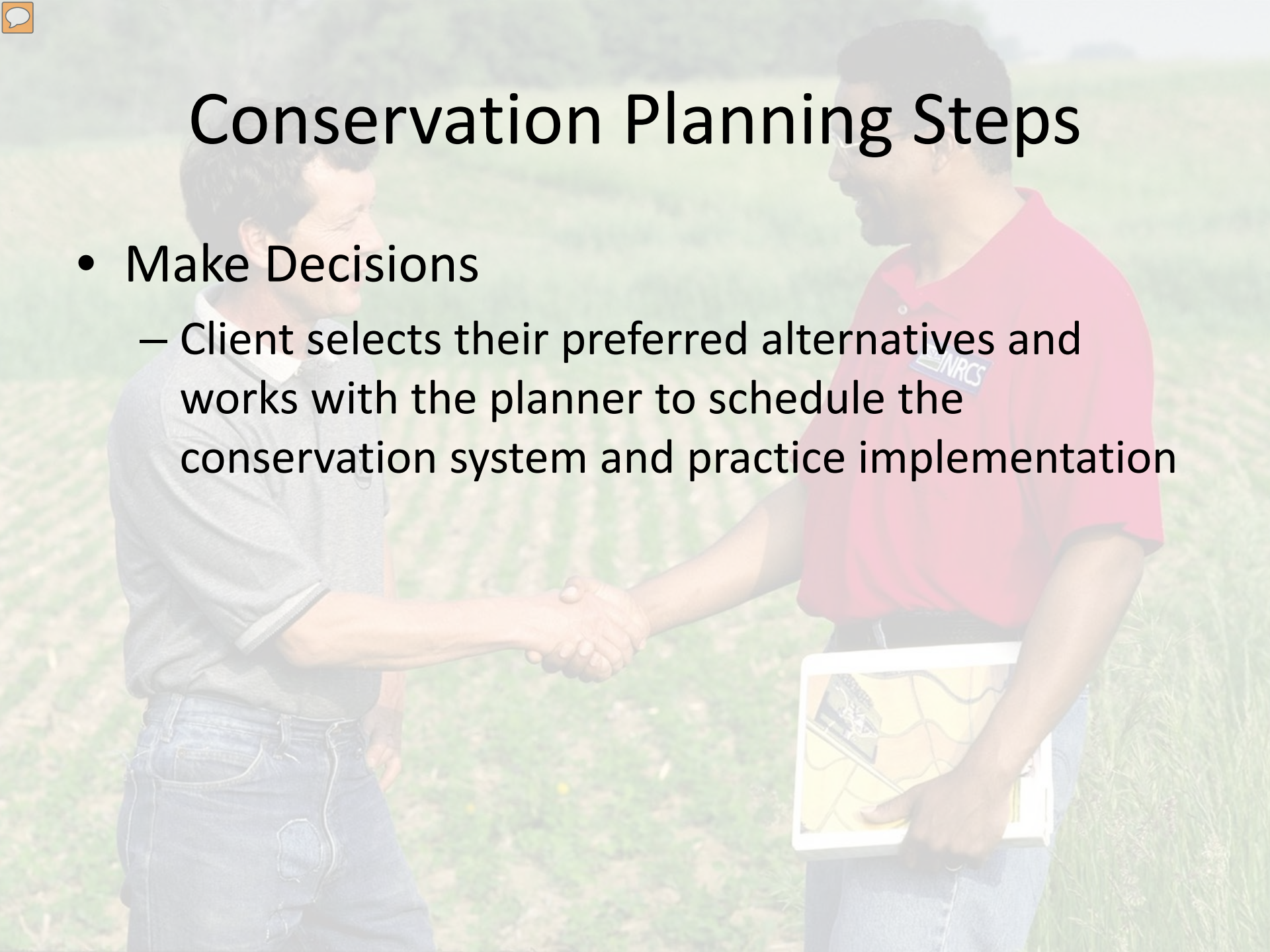
- Formulate Alternatives
  - Formulate alternatives that will achieve the client's objectives, solve identified natural resource concerns, and take advantage of opportunities to improve or protect resource conditions, and demonstrate a variety of technical and economic implementation strategies.

Conservation Planning Steps

- Evaluate Alternatives
  - Evaluate the alternatives to determine their effects in addressing the client's objectives and the identified natural resource concerns and opportunities.
  - Evaluate the projected effects on social, economic, and ecological concerns.

Conservation Planning Steps

- Make Decisions
  - Client selects their preferred alternatives and works with the planner to schedule the conservation system and practice implementation



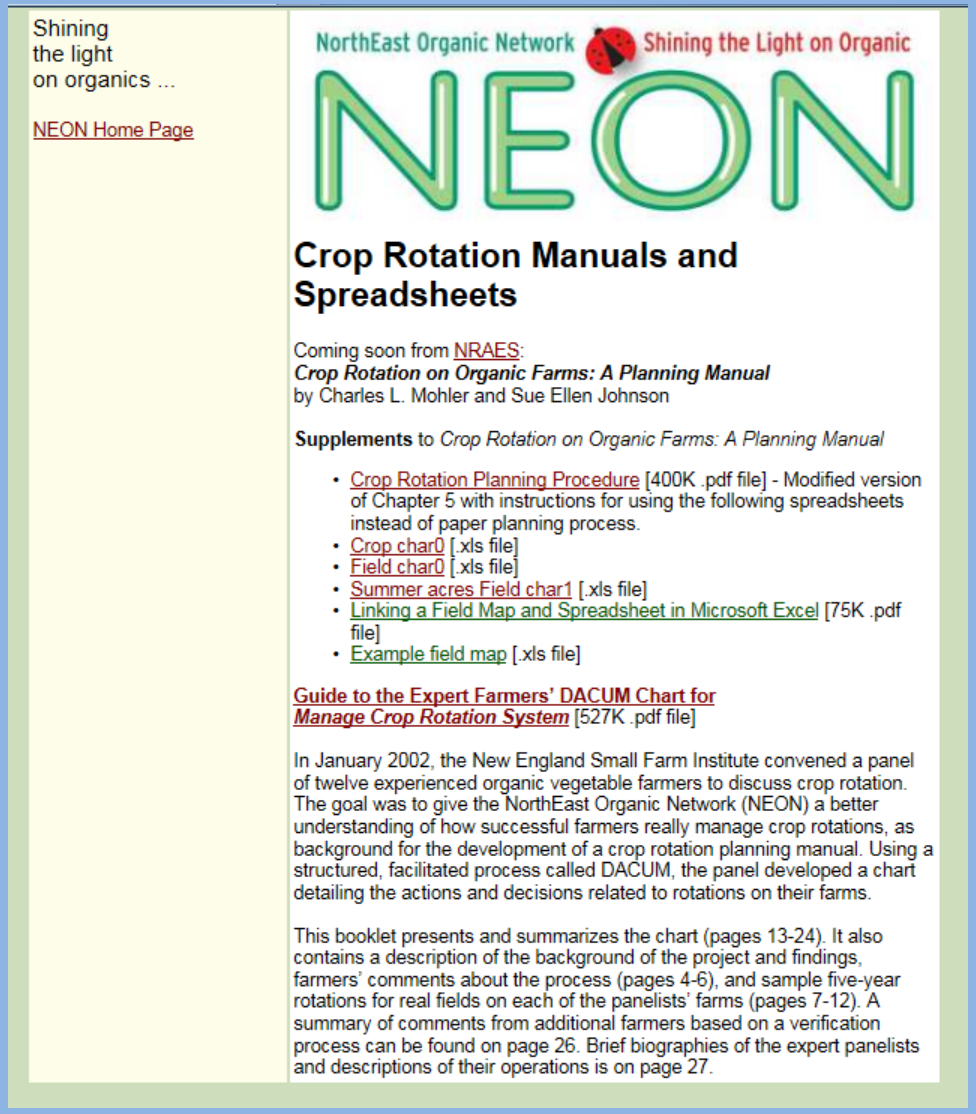
Conservation Planning Steps

- Implement the Plan
  - Client implements the selected alternatives
  - Planner or technical expert provides the land manager with detailed practice implementation information, including engineered designs.
  - Conservation staff will also provide practice layout, construction inspection, and certification.

Conservation Planning Steps

- Evaluate the Plan
  - Evaluate the effectiveness of the plan in solving the resource concerns as it is implemented and work with the client to make adjustments as needed.

Tools & Resources



Shining
the light
on organics ...

NEON Home Page

NorthEast Organic Network — Shining the Light on Organic

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Crop Rotation Manuals and Spreadsheets

Coming soon from NRAES:
Crop Rotation on Organic Farms: A Planning Manual
by Charles L. Mohler and Sue Ellen Johnson

Supplements to *Crop Rotation on Organic Farms: A Planning Manual*

- Crop Rotation Planning Procedure [400K .pdf file] - Modified version of Chapter 5 with instructions for using the following spreadsheets instead of paper planning process.
- Crop char0 [.xls file]
- Field char0 [.xls file]
- Summer acres Field char1 [.xls file]
- Linking a Field Map and Spreadsheet in Microsoft Excel [75K .pdf file]
- Example field map [.xls file]

Guide to the Expert Farmers' DACUM Chart for *Manage Crop Rotation System* [527K .pdf file]

In January 2002, the New England Small Farm Institute convened a panel of twelve experienced organic vegetable farmers to discuss crop rotation. The goal was to give the NorthEast Organic Network (NEON) a better understanding of how successful farmers really manage crop rotations, as background for the development of a crop rotation planning manual. Using a structured, facilitated process called DACUM, the panel developed a chart detailing the actions and decisions related to rotations on their farms.

This booklet presents and summarizes the chart (pages 13-24). It also contains a description of the background of the project and findings, farmers' comments about the process (pages 4-6), and sample five-year rotations for real fields on each of the panelists' farms (pages 7-12). A summary of comments from additional farmers based on a verification process can be found on page 26. Brief biographies of the expert panelists and descriptions of their operations is on page 27.

http://www.neon.cornell.edu/croprotation/

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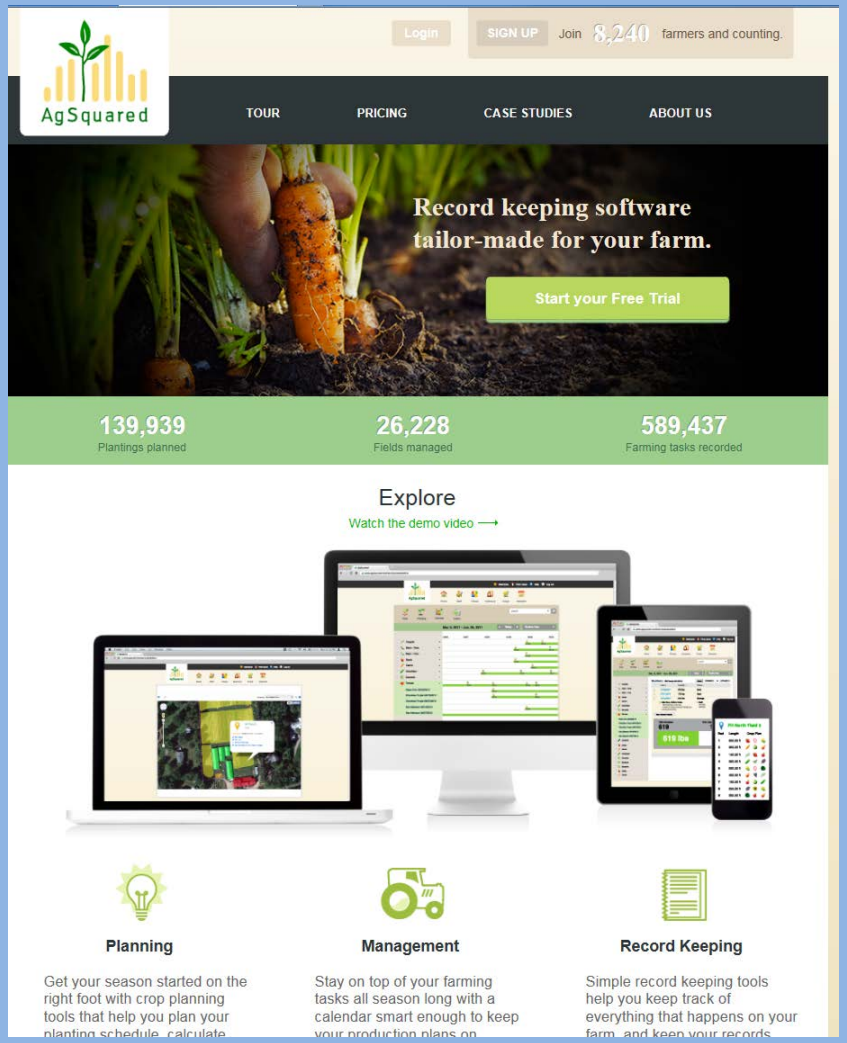

http://www.agsquared.com/

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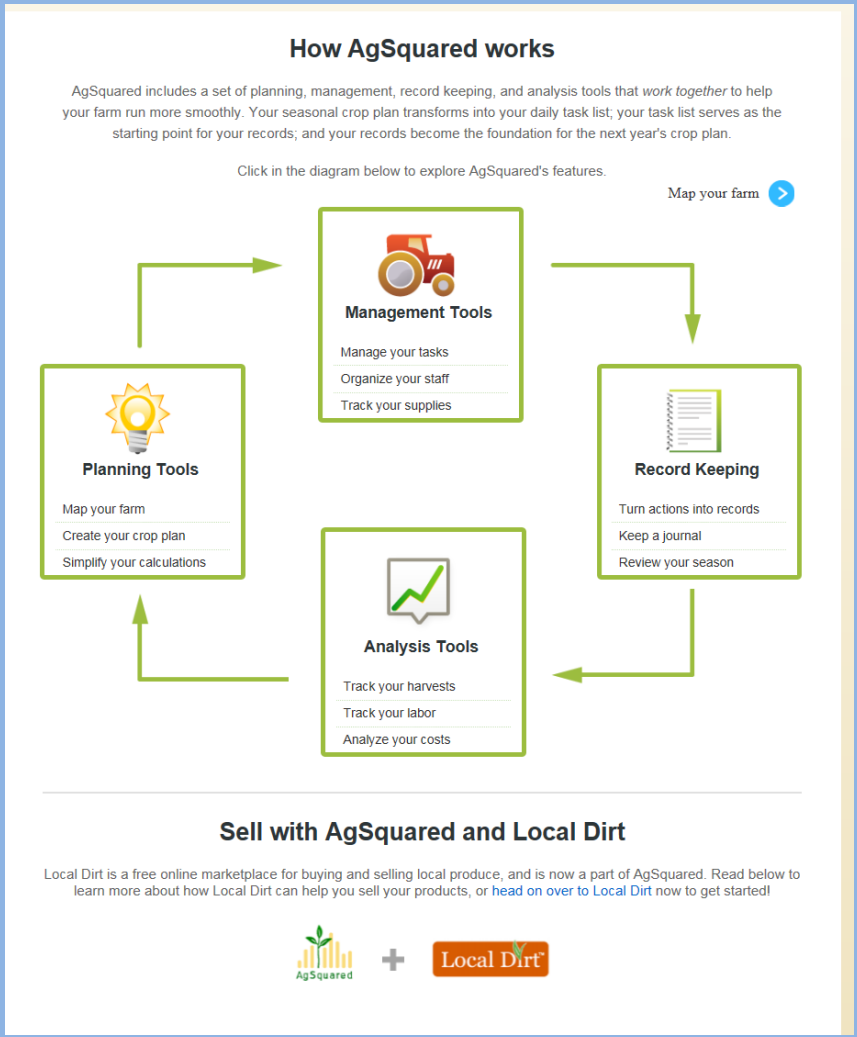

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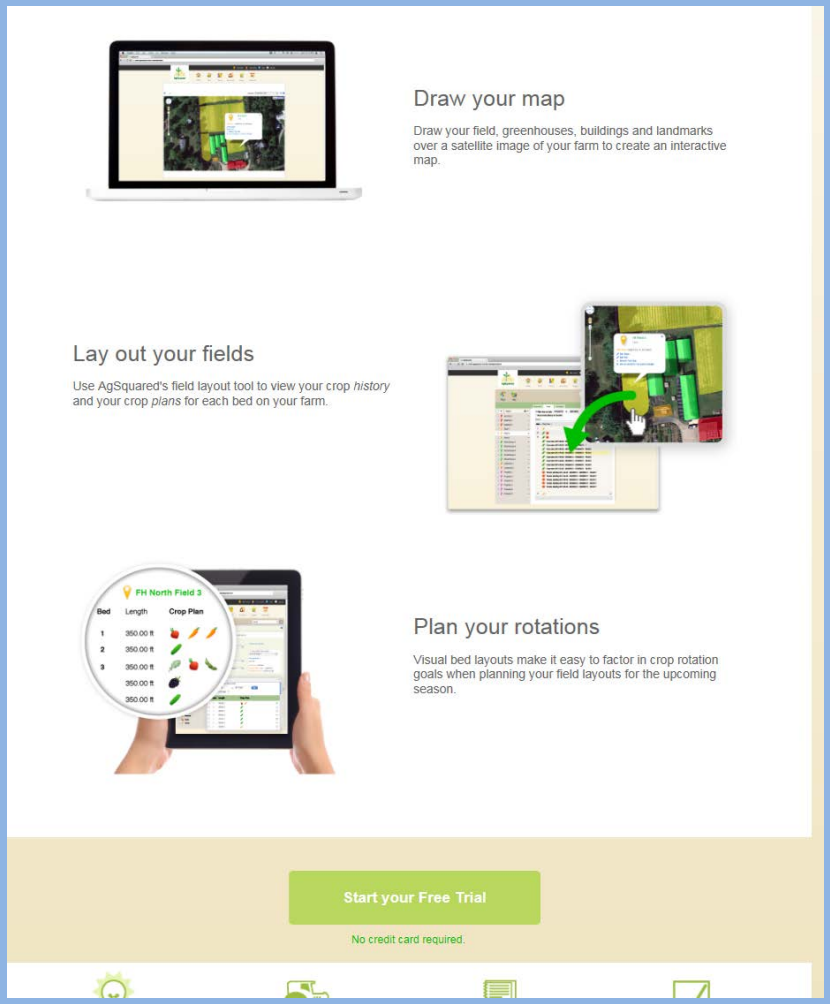

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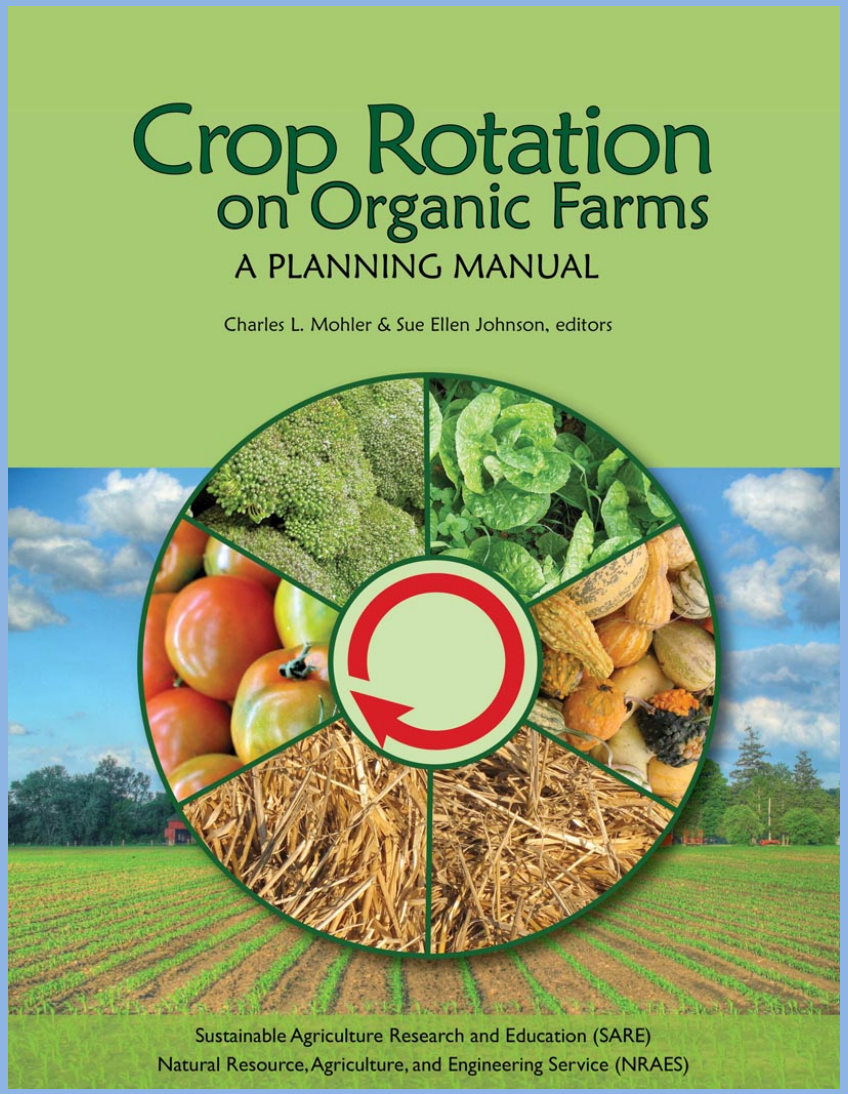

Tools & Resources

United States Department of Agriculture

Natural Resources Conservation Service

National Planning Procedures Handbook (NPPH), Edition 1

(180-600-H, 1st Ed., Amend. 6, Nov 2014)

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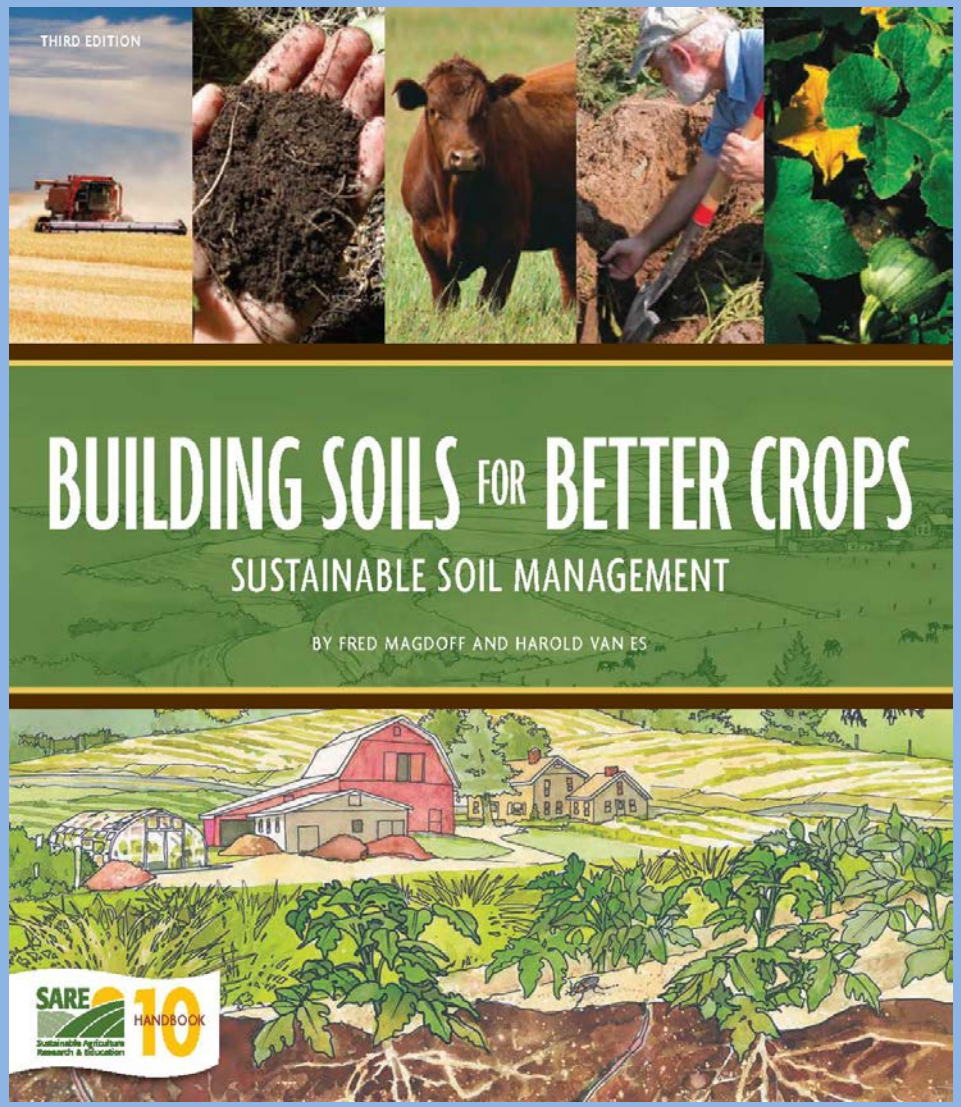

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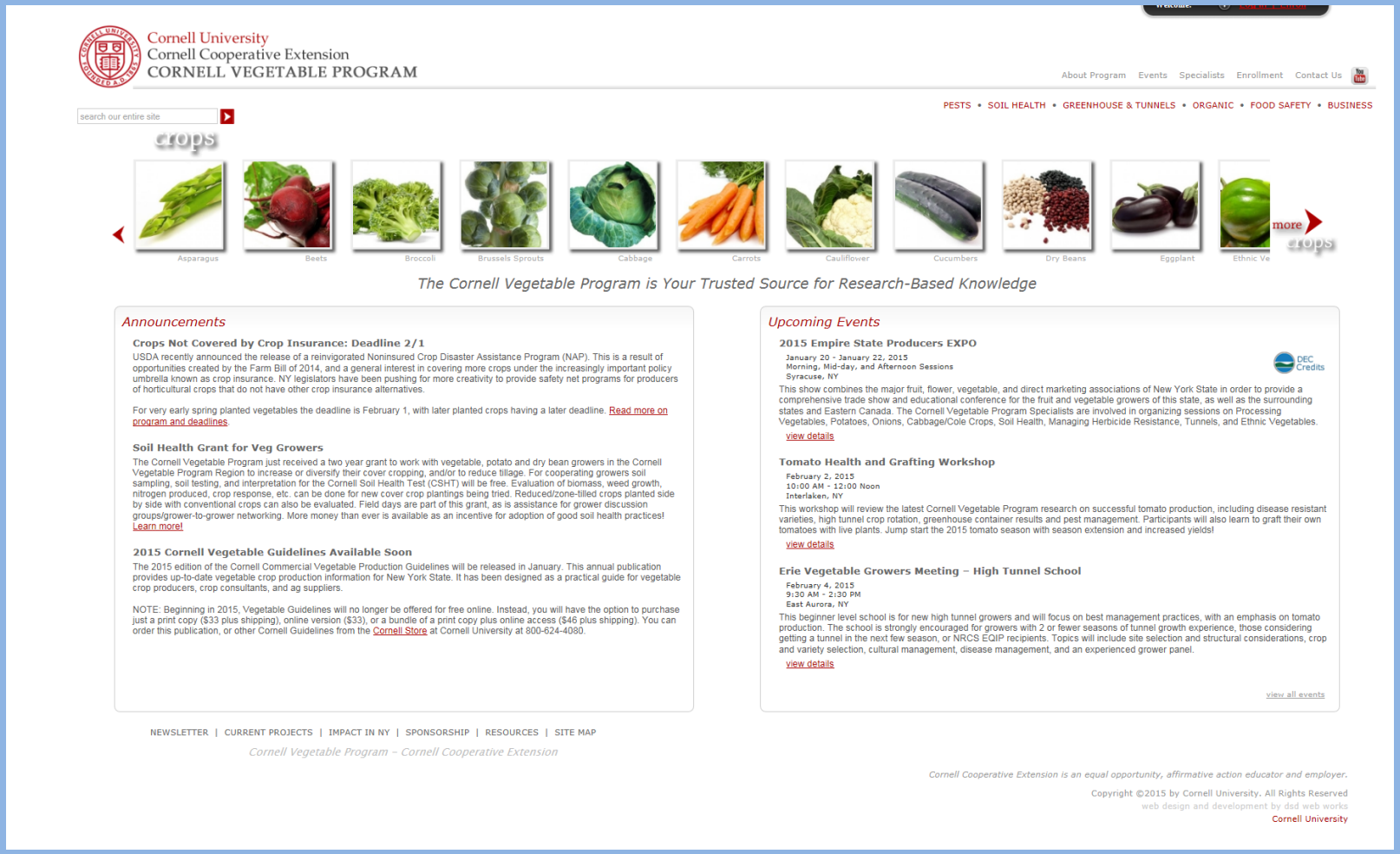
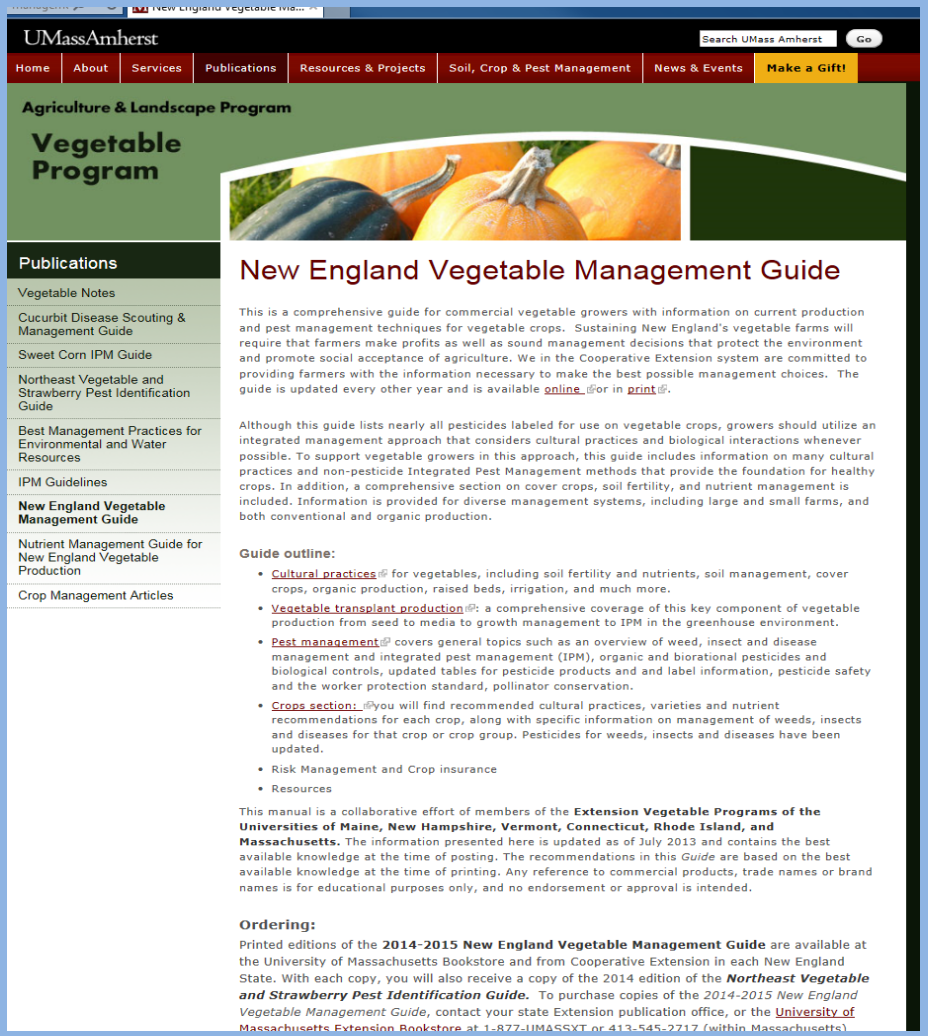
https://nevegetable.org/cultural-practices/crop-rotation

Tools & Resources



http://cvp.cce.cornell.edu/

Tools & Resources



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Publications

- Vegetable Notes
- Cucurbit Disease Scouting & Management Guide
- Sweet Corn IPM Guide
- Northeast Vegetable and Strawberry Pest Identification Guide
- Best Management Practices for Environmental and Water Resources
- IPM Guidelines
- **New England Vegetable Management Guide**
- Nutrient Management Guide for New England Vegetable Production
- Crop Management Articles

New England Vegetable Management Guide

This is a comprehensive guide for commercial vegetable growers with information on current production and pest management techniques for vegetable crops. Sustaining New England's vegetable farms will require that farmers make profits as well as sound management decisions that protect the environment and promote social acceptance of agriculture. We in the Cooperative Extension system are committed to providing farmers with the information necessary to make the best possible management choices. The guide is updated every other year and is available online or in print.

Although this guide lists nearly all pesticides labeled for use on vegetable crops, growers should utilize an integrated management approach that considers cultural practices and biological interactions whenever possible. To support vegetable growers in this approach, this guide includes information on many cultural practices and non-pesticide Integrated Pest Management methods that provide the foundation for healthy crops. In addition, a comprehensive section on cover crops, soil fertility, and nutrient management is included. Information is provided for diverse management systems, including large and small farms, and both conventional and organic production.

Guide outline:

- Cultural practices for vegetables, including soil fertility and nutrients, soil management, cover crops, organic production, raised beds, irrigation, and much more.
- Vegetable transplant production: a comprehensive coverage of this key component of vegetable production from seed to media to growth management to IPM in the greenhouse environment.
- Pest management covers general topics such as an overview of weed, insect and disease management and integrated pest management (IPM), organic and biorational pesticides and biological controls, updated tables for pesticide products and and label information, pesticide safety and the worker protection standard, pollinator conservation.
- Crops section: you will find recommended cultural practices, varieties and nutrient recommendations for each crop, along with specific information on management of weeds, insects and diseases for that crop or crop group. Pesticides for weeds, insects and diseases have been updated.
- Risk Management and Crop insurance
- Resources

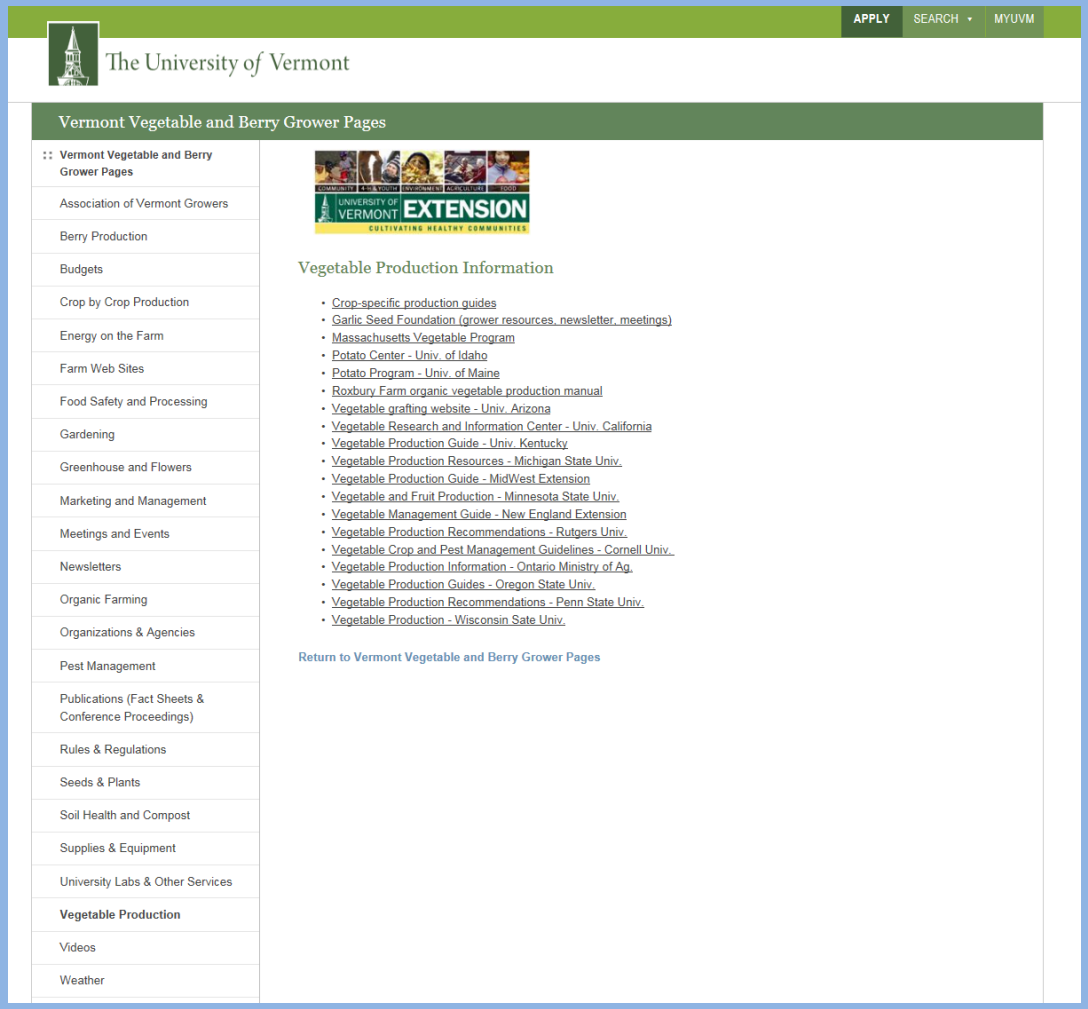
This manual is a collaborative effort of members of the **Extension Vegetable Programs of the Universities of Maine, New Hampshire, Vermont, Connecticut, Rhode Island, and Massachusetts.** The information presented here is updated as of July 2013 and contains the best available knowledge at the time of posting. The recommendations in this *Guide* are based on the best available knowledge at the time of printing. Any reference to commercial products, trade names or brand names is for educational purposes only, and no endorsement or approval is intended.

Ordering:

Printed editions of the **2014-2015 New England Vegetable Management Guide** are available at the University of Massachusetts Bookstore and from Cooperative Extension in each New England State. With each copy, you will also receive a copy of the 2014 edition of the ***Northeast Vegetable and Strawberry Pest Identification Guide.*** To purchase copies of the *2014-2015 New England Vegetable Management Guide*, contact your state Extension publication office, or the University of Massachusetts Extension Bookstore at 1-877-UMASSXT or 413-545-2717 (within Massachusetts)

http://extension.umass.edu/vegetable/publications/new-england-vegetable-management-guide

Tools & Resources



http://www.uvm.edu/vtvegandberry/?Page=veglinks.html

Tools & Resources

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