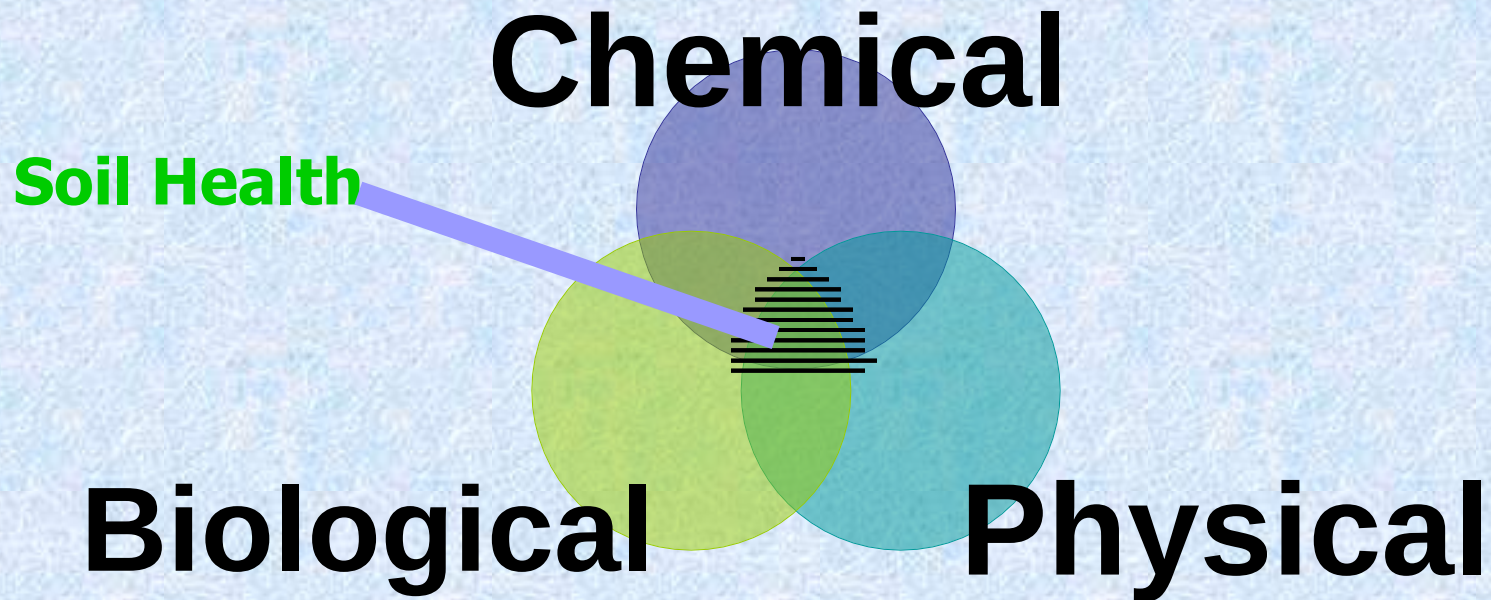


Soil Health on Organic Vegetable Farms



You Know This



What are some soil health goals and ‘best practices’?

What range of approaches are farmers using to implement those practices?

Goals

Manage soil nutrients, pH

Maintain passive OM

Supply active OM

Maintain soil structure

Avoid compaction, erosion

Practices

Soil testing

Add soil amendments

Cover crop

Reduce tillage

Rotate crops

soil tests

pH

Plant nutrients: reserve or soluble

Soluble salts (electrical conductivity)

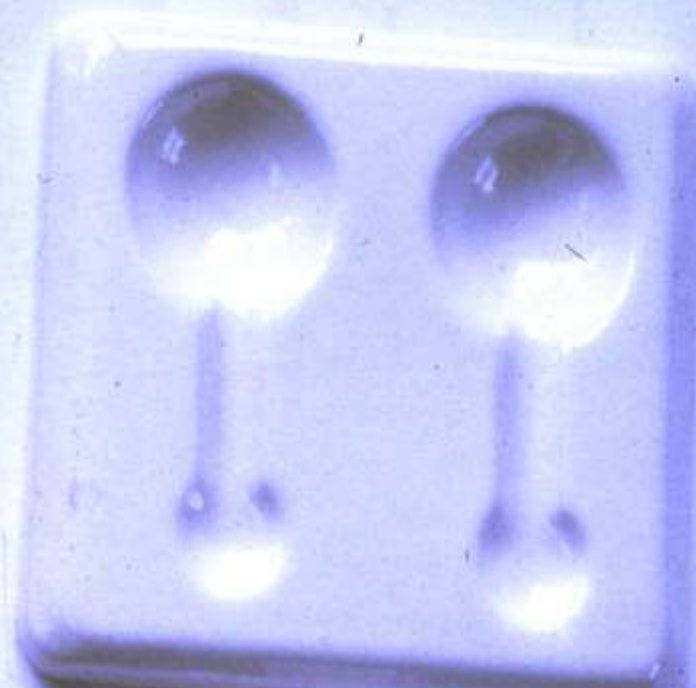
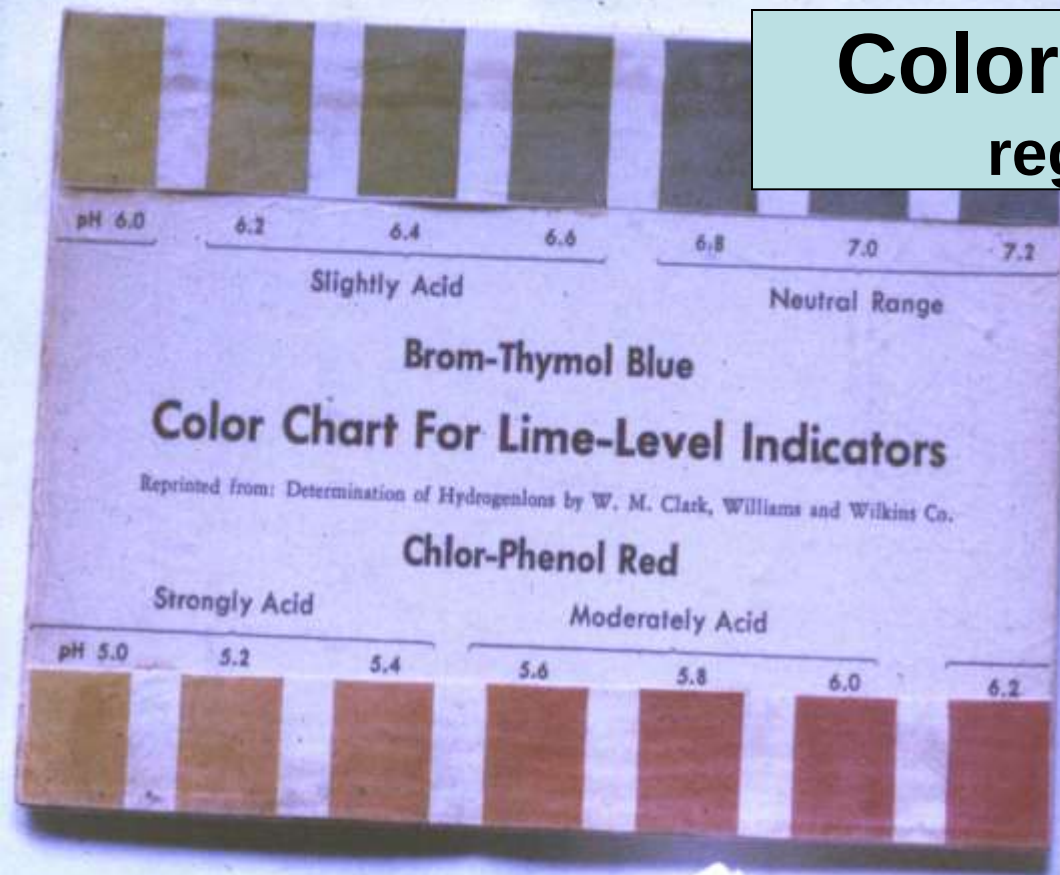
Nitrogen: NH_4 , NO_3 , mineralizable

Organic matter: active or passive

Biological activity

Compaction: surface or subsurface

Colorimetric test for pH regular or wide range



~\$20 including shipping

<http://cna1.cals.cornell.edu/forms/phkit.html>



SOIL TEST RESULTS

pH (salt)		5.3
Available Phosphate (1b P ₂ O ₅ /A)		44
Potash (1b K ₂ O/A)		420
Magnesium (1b Mg/A)		159
Reserve Phosphate (1b P ₂ O ₅ /A)		748
Aluminum (1b Al/A)		83
Calcium (1b Ca/A)		1600
Effective CEC (meq/100g)		5.1
Zinc (medium) (ppm Zn)		0.6

LOW

MEDIUM

Field soil test – ‘reserve’ nutrients

Labs use different extracts: Morgan, Bray, Mehlich, etc.

LIME
TONS/ACRE

NITROGEN (N)
lbs./ACRE

PHOSPHATE (P₂O₅)
lbs./ACRE

POTASH (K₂O)
lbs./ACRE

LIME & NUTRIENTS NEEDED:

3.0

0

0

0

CONTRIBUTION FROM MANURE:

24

13

44

BALANCE NEEDED FROM FERTILIZER:

3.0

0

0

0

Rate of lime recommended is to raise soil pH to 6.5

Broadcast lime before or during seedbed preparation and harrow in.

High magnesium lime may be the most economical source for your magnesium

N contribution from manure was adjusted for past manure application at

Saturated media or potting soil test: measures water-soluble nutrients

(similar tests are 1:2 dilution, leachate pour-through)

ANALYSIS OF SATURATION EXTRACT

pH: 6.9
Soluble Salts (mS/cm): 2.27

<u>Macronutrients</u>	<u>mg/L</u>
<u>Nitrate-N (NO₃-N):</u>	162
<u>Ammonium-N (NH₄-N):</u>	3
<u>Phosphorus (P):</u>	8
Potassium (K):	112
Calcium (Ca):	211
Magnesium (Mg):	116
Sulfur (S):	96

<u>Micronutrients</u>	<u>mg/L</u>
Zinc (Zn):	0.04
Boron (B):	0.18
Manganese (Mn):	0.04
Copper (Cu):	0.10
Iron (Fe):	0.69
Sodium (Na):	83.19

useful for managing tunnels and GH soils
(especially in combination with field soil test)
\$15-30 depending on lab

University of Maine
long term high tunnel soil test
\$22



PHYSICAL	Aggregate Stability (%)	19.4	2	aeration, infiltration, rooting
	Available Water Capacity (m/m)	0.20	7	
	Bulk Density (g/cc)	1.45	1	rooting, water transmission
	Surface Hardness (psi)	222	1	rooting, water transmission
	Subsurface Hardness (psi)	292	2	Subsurface Pan/Deep Compaction
BIOLOGICAL	Organic Matter (%)	3.3	1	energy storage, C sequestration, water retention
	Active Carbon (ppm)	555	3	
	Potentially Mineralizable Nitrogen ($\mu\text{gN/gdwsoil/week}$)	4.0	2	N supply capacity, N leaching potential
	Root Health Rating (1-9)	5	5	
CHEMICAL	pH (see attached CNAL Report)	7.2	10	
	Extractable Phosphorus (see attached CNAL Report)	11	10	
	Extractable Potassium (see attached CNAL Report)	63	10	
	Micronutrients (see attached CNAL Report)	ADEQUATE	10	

**Cornell
Soil Health Test
\$85**

<http://soilhealth.cals.cornell.edu/extension/test.htm>

- Particle size distribution and texture
- Wet aggregate stability
- Available water capacity
- Surface hardness (you do on farm)
- Subsurface hardness (you do on farm)
- Organic matter
- Active carbon
- Soil respiration - new in 2014
- Soil protein - new in 2014
- Root pathogen pressure
- Standard fertility test

How much of what kind of fertilizers to apply?

Nitrogen (N)	Phosphate (P ₂ O ₅)	Potash (K ₂ O)
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1.Recommendations:			
--------------------	--	--	--

Nutrient credits:

Manure			
Compost			
prior cover crop			
soil organic matter		---	---
2. Total credits:			

Total needed (1-2) =			
----------------------	--	--	--

common organic fertilizers

N: dried blood, Chilean nitrate,
some seed meals: canola, peanut, soy

P: rock phosphate
bone char, bone meal

K: potassium sulfate, sul-po-mag,
greensand, wood ash

Ca: lime, gypsum

Mg: lime, sul-po-mag, epsom salts

vegetable nutrient recommendations vary a lot by state

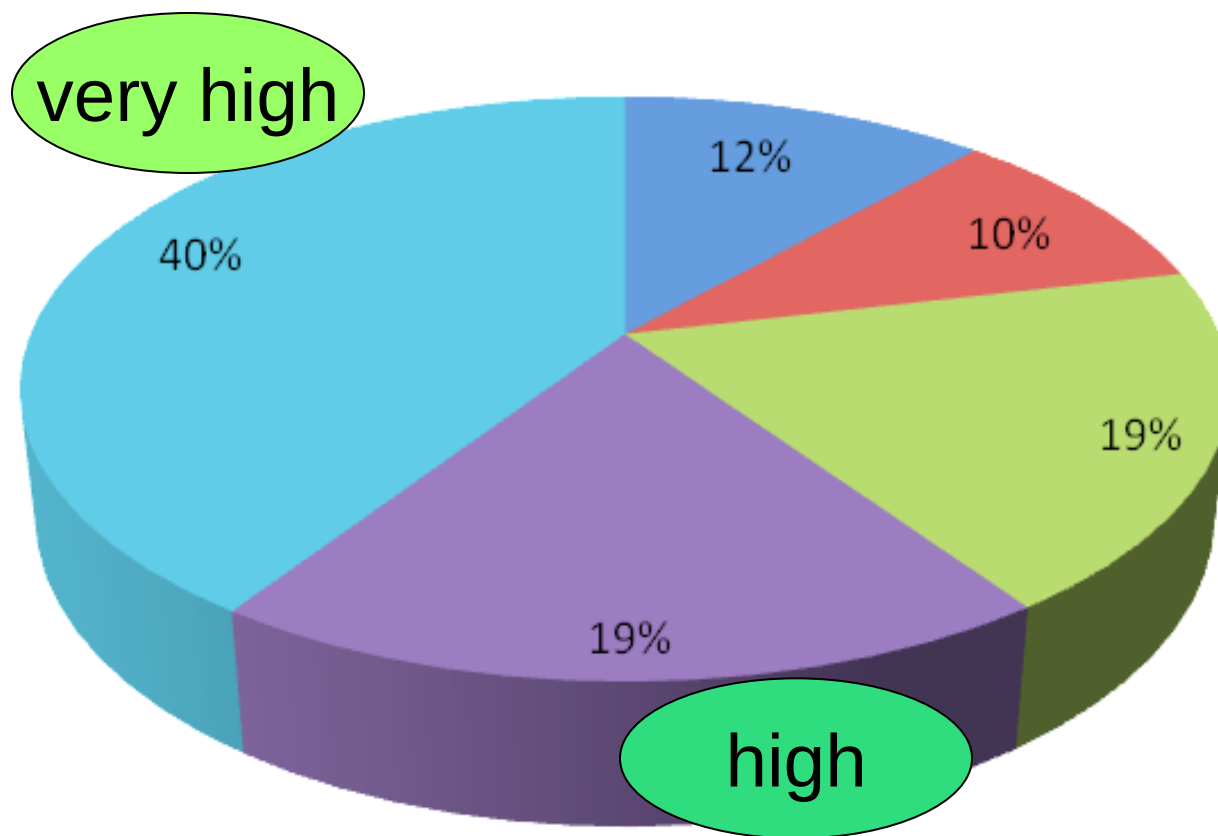
make your best estimate...

CABBAGE, BROCCOLI, CAULIFLOWER AND OTHER BRASSICA CROPS	Nitrogen (N)* Lbs per acre	Phosphorus (P) Lbs P ₂ O ₅ per acre				Potassium (K) Lbs K ₂ O ₅ per acre			
	Soil Test Results	Very Low	Low	Optimum	Above Optimum	Very Low	Low	Optimum	Above Optimum
Broadcast and Incorporate	100	150	100	50	0	175	125	50	0
Sidedress 4 weeks after transplant	60**	0	0	0	0	0	0	0	0
TOTAL RECOMMENDED	160	150	100	50	0	175	125	50	0

New England Extension

	Pounds N per Acre	Soil Phosphorus Level				Soil Potassium Level				Nutrient Timing and Method
		Low	Med	High	Very	Low	Med	High	Very	
				(Opt.)	High			(Opt.)	High	
		Pounds P ₂ O ₅ per Acre				Pounds K ₂ O per Acre				
Broccoli	150-200	200	100	50	0 ¹	200	100	50	0 ¹	Total nutrient recommended.
	50-100	200	100	50	0 ¹	200	100	50	0 ¹	Broadcast and disk-in.
	50	0	0	0	0	0	0	0	0	Sidedress 2-3 weeks after planting.
	50	0	0	0	0	0	0	0	0	Sidedress 4-6 weeks after planting.
Brussels Sprouts,	100-150	200	100	50	0 ¹	200	100	50	0 ¹	Total nutrient recommended.
Cabbage,	50-75	200	100	50	0 ¹	200	100	50	0 ¹	Broadcast and disk-in.
Cauliflower	25-50	0	0	0	0	0	0	0	0	Sidedress 2-3 weeks after planting.
Kale, Collards	100-200	200	100	50	0 ¹	200	100	50	0 ¹	Total nutrient recommended.
	50-100	200	100	50	0 ¹	200	100	50	0 ¹	Broadcast and disk-in.
	25-50	0	0	0	0	0	0	0	0	Sidedress after each cutting or stripping.
Kohlrabi	25-50	0	0	0	0	0	0	0	0	Total nutrient recommended.
	25-50	0	0	0	0	0	0	0	0	Sidedress if needed according to weather.

Maintaining OM and adding N without P ...a challenge for many farms



over half Vermont vegetable fields tested high or very high in P

On soils with 'excessive' P

- 1) Apply little or no compost, manure or 'blended fertilizers'**
- 2) Use legumes as primary source of N, plus grasses to maintain soil OM**
- 3) Use bagged fertilizer for N, K as needed**



PRO-GRO 5-3-4 A NATURAL/ORGANIC FERTILIZER

This product is blended from the following list of natural ingredients:

BONEMEAL
ROCK PHOSPHATE
COLLOIDAL PHOSPHATE
CYSTER MEAL
KELP MEAL

GREENSAND
LANGBEINITE
VEGETABLE PROTEIN MEALS
MEAT AND BONE MEAL

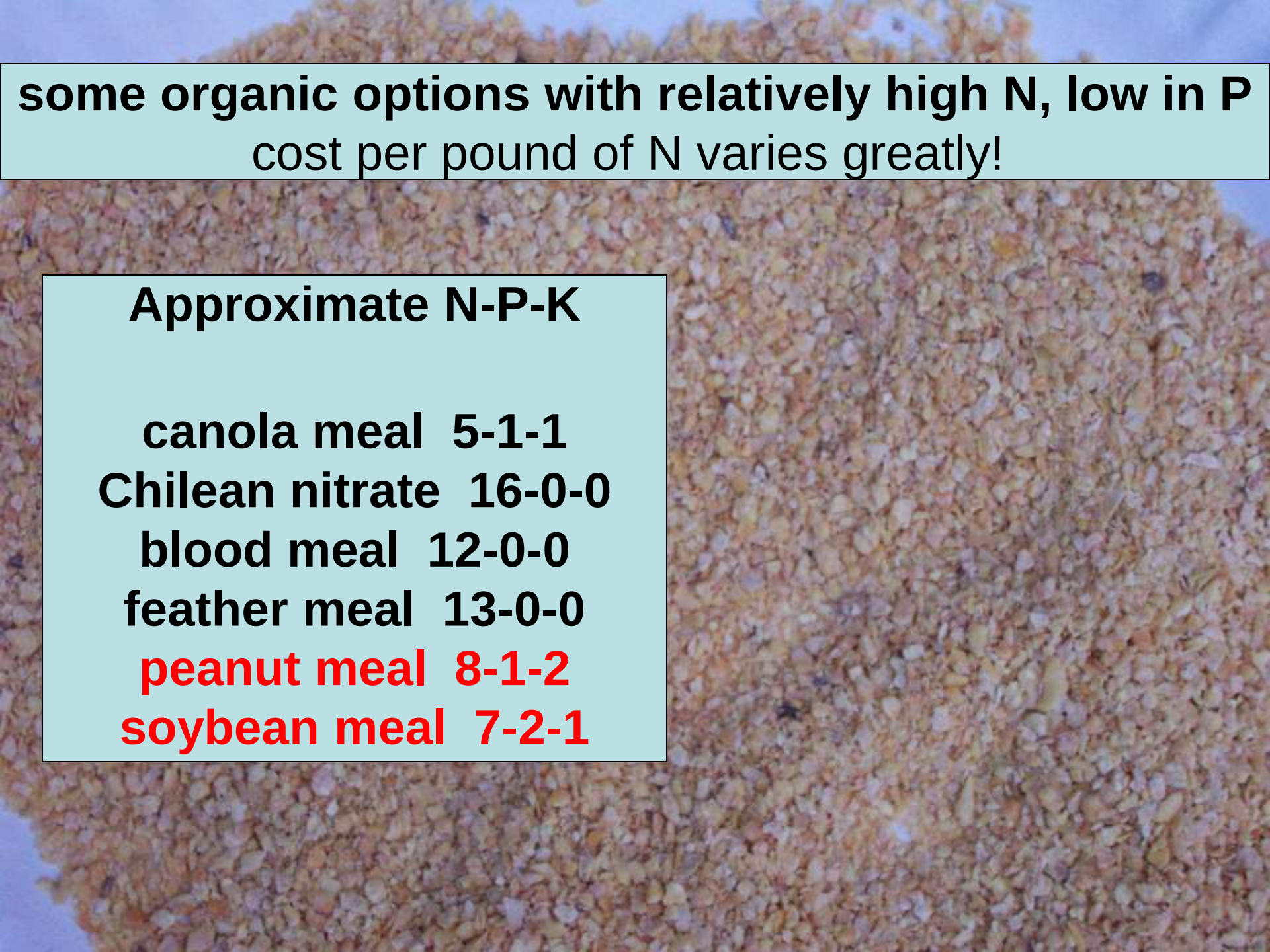
NATURAL NITRATE OF SODA
LEATHER NEAL
FISH MEAL
BENEFICIAL BACTERIA
HUMATES
TRACE MINERALS

N-P-K fertilizers

DEHYDRATED ALFALFA

NET WEIGHT 50 LBS. (22.68KG)





some organic options with relatively high N, low in P
cost per pound of N varies greatly!

Approximate N-P-K

canola meal 5-1-1

Chilean nitrate 16-0-0

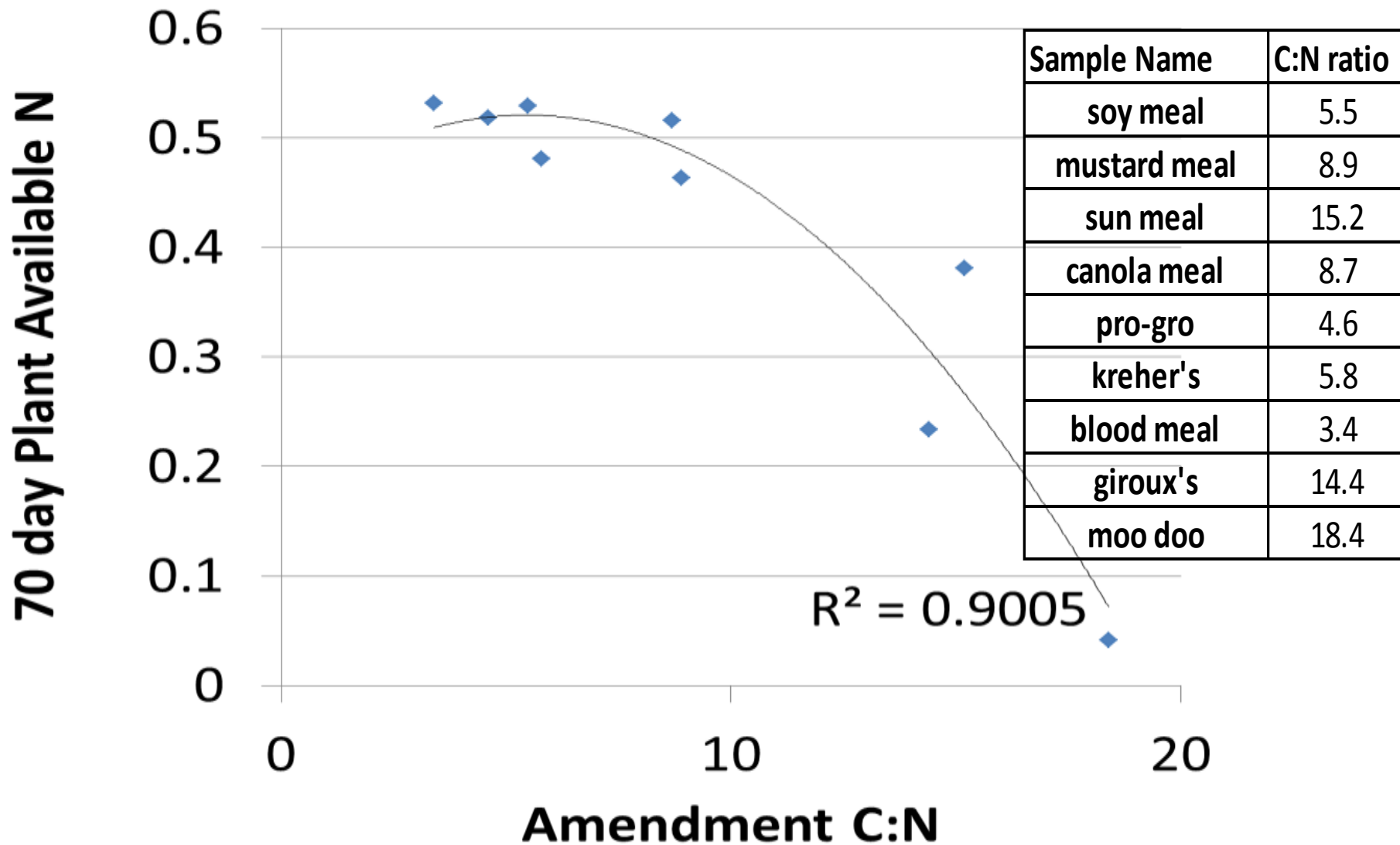
blood meal 12-0-0

feather meal 13-0-0

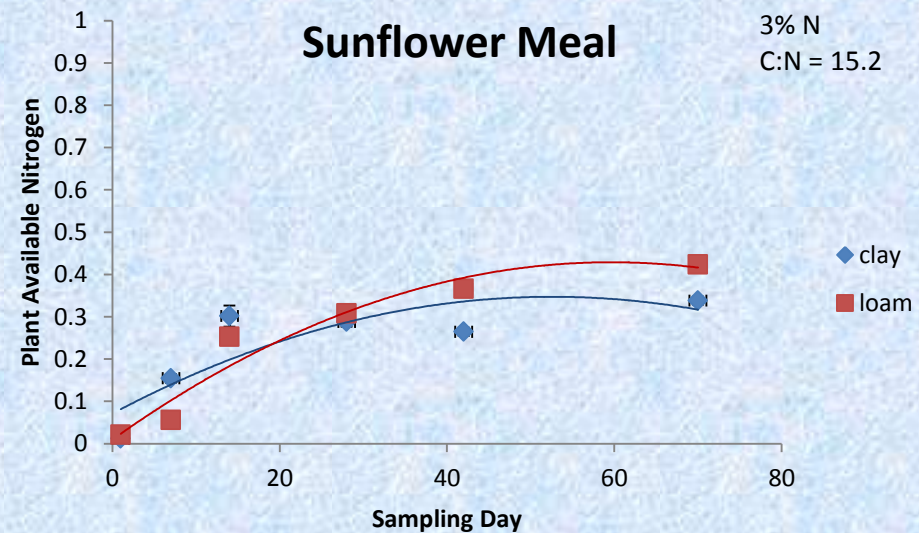
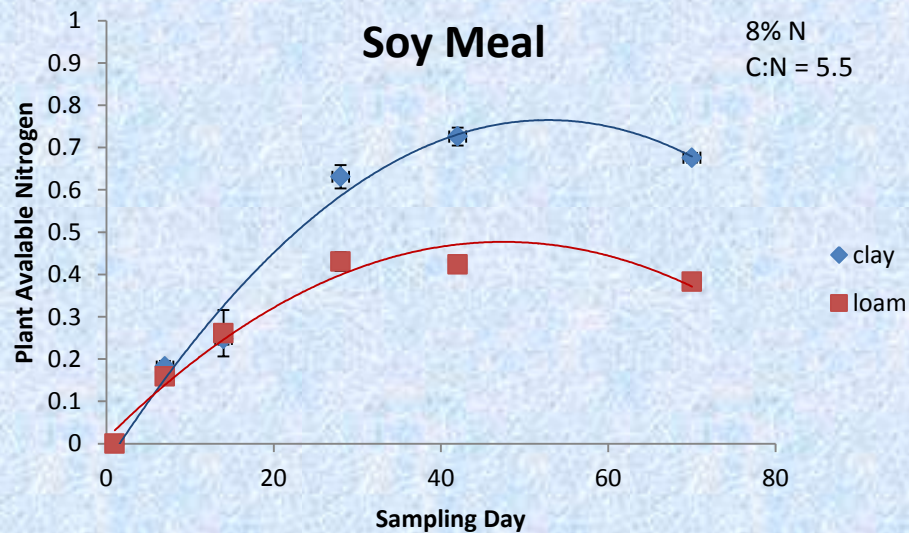
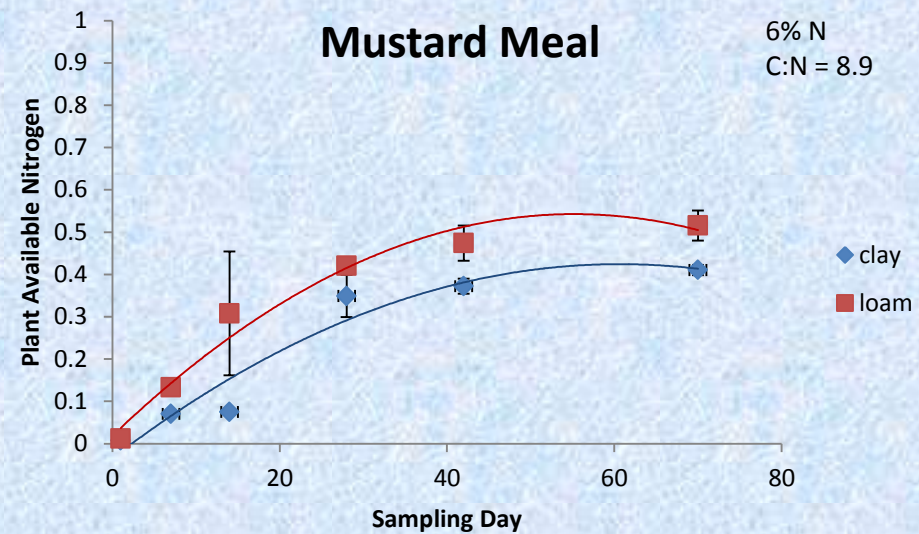
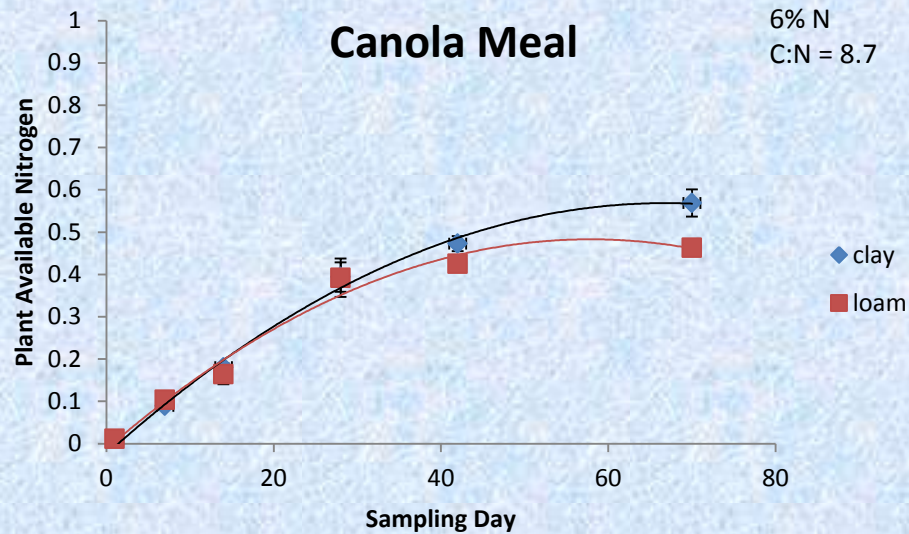
peanut meal 8-1-2

soybean meal 7-2-1

C:N Ratio affects PAN



Seed meals released N steadily during incubation studies



Cost per lb of nutrient (50 lb bags 2014 NOFA bulk order)

5-5-5 Custom @ \$22 = N, P, and K \$8.80/lb each

4-3-3 CheepCheep @ \$18.50 = N, P, K \$9.25/lb each

6-0-6 Custom @\$27 = N, K \$9/lb each

2.5-.5-2.2 Alfalfa Meal @ \$28.50 = \$22/lb N, \$26/lb K

12-0-0 Blood Meal @t \$77 = \$13/lb N

8-1-0 Peanut Meal @\$31.50 = \$7.88/lb N

10-0-0 Pro-Booster @\$31.50 = \$6.30/lb N

7-1-2 Conventional Soymeal @ \$17 = \$4.86/lb N

0-0-51 Sulfate of Potash @ \$51 = \$2/lb K

0-0-22-11 Sul-Po-Mag @ \$37 = \$3.27/lb K

cover crops



Cover crop 'systems'

- Winter and/or Spring Covers (Cool)
- Summer 'Smother' Crops (Warm)
- Year-Long Cover Crop (Fallow)
- Interseeding / Undersowing (Strips)

winter rye is reliable, can be hard to kill



winter-killed oats
Chapelle's Potatoes



Frost-seeded red clover

Wood's Market Garden



Canada field pea

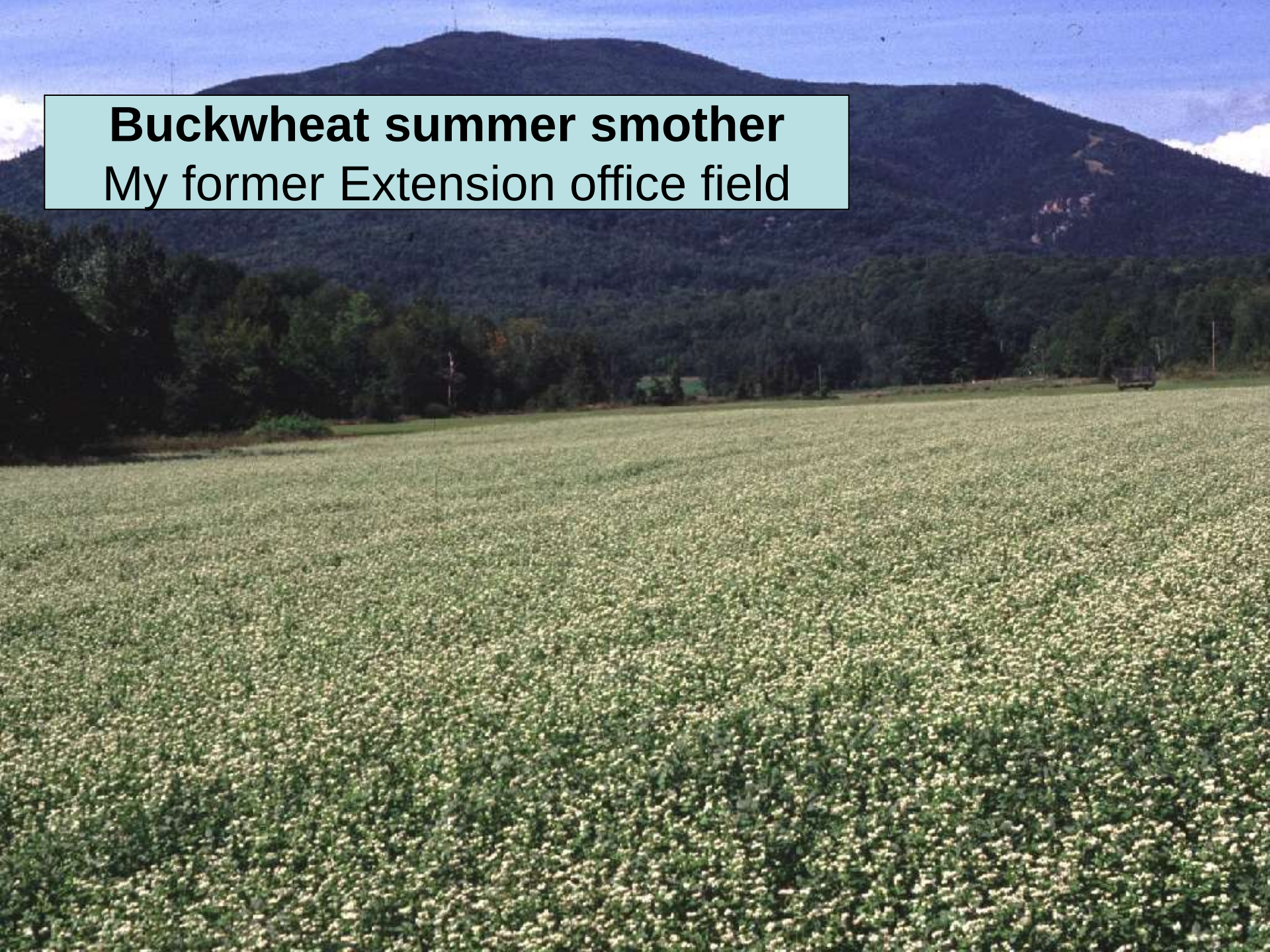


Mowed Sudax cover crop – fallow year

Gildrien Farm



Buckwheat summer smother
My former Extension office field



Sow thickly, grow for 30-40 days, mow at flowering



Soybeans on 9/15, sown 5/15



Cowpeas on 9/15, sown 5/15



Sesbania on 9/15, sown 5/15



Crotolaria on 9/15, sown 5/15



Mixed species: Sudax plus red clover



Fall-sown hairy vetch and rye

Lewis Creek Farm



Spring-sown oats, peas turnips

Eveningsong Farm



Strips: white clover between wide-spaced crops

Edgewater Farm



Ryegrass between plasticulture vegetables

Riverberry Farm



- Push drop spreader rides edge of plastic
- Seed annual ryegrass at 30 lb/A
- At \$30 for 50 lb, cost is \$18/A of plastic
- Key is sow early – cool, before weeds
- Use 1.2 mil or thicker plastic, for removal



**Mow with self-propelled
Echo/Bearcat string trimmer**



Strawberry Plasticulture

Darby Farm



- Dwarf ryegrass, 100 lb/A ~\$1/lb
- Sow early after laying plastic
- Till or lightly rake in
- Mow or string trim
- Apply straw in second year

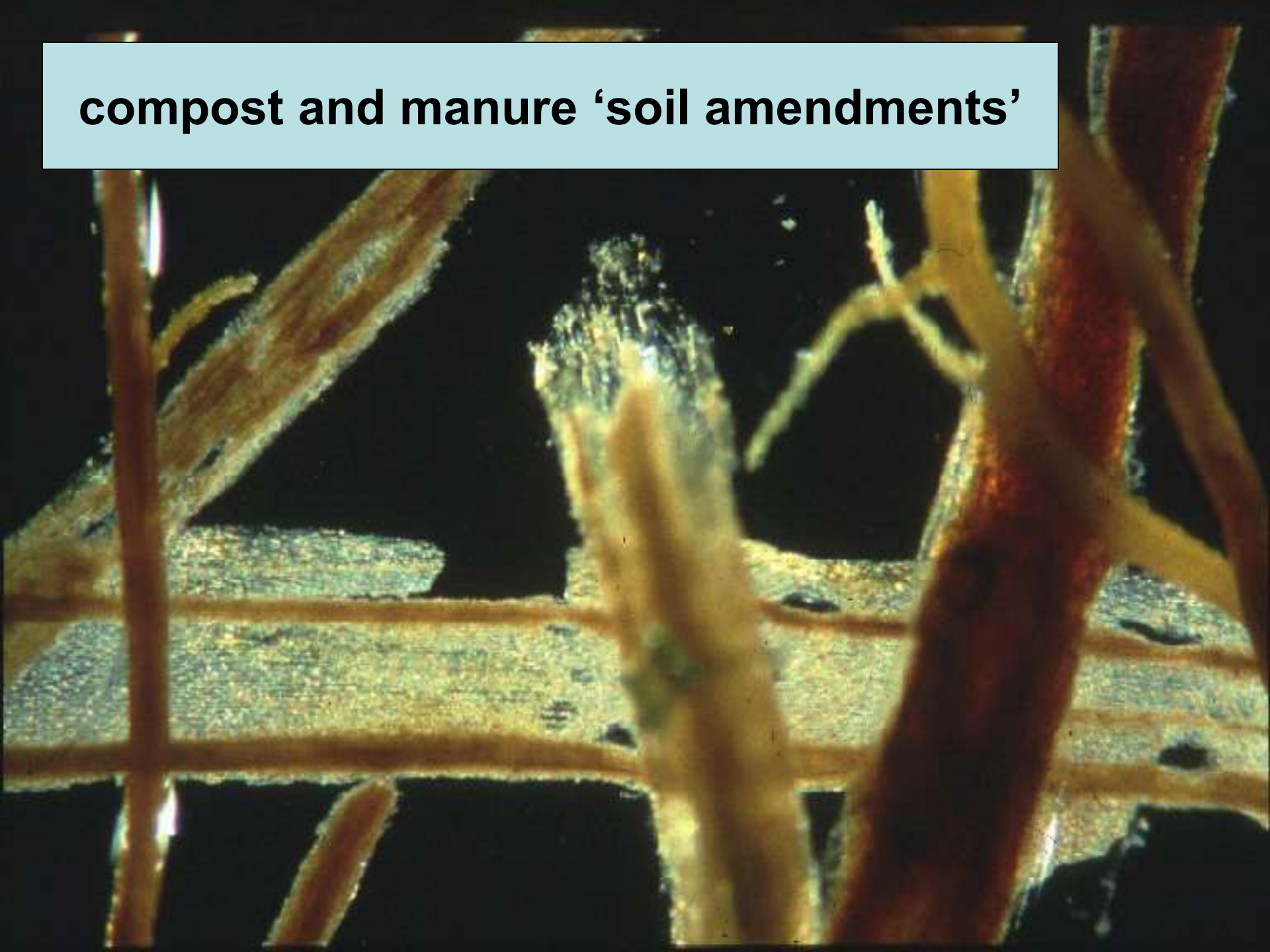
07/02/2010

mowing maturing rye to cover plastic mulch



Elderberry Pond Farm

compost and manure 'soil amendments'





**manure issues:
food safety, P content, weed seeds**



**compost issues:
cost, N availability, P content, herbicide?**

make it or buy it – actual costs?



Available vocal ingredients?
lake weeds, Foggy Bottom Farm





Compaction and tillage



**sub-surface compaction is a common problem
usually at just under a foot deep**



subsoiler



deep zone tiller



organic weed management within and between the rows is challenging in this system



Yeoman's plow

reduced till organic pumpkins

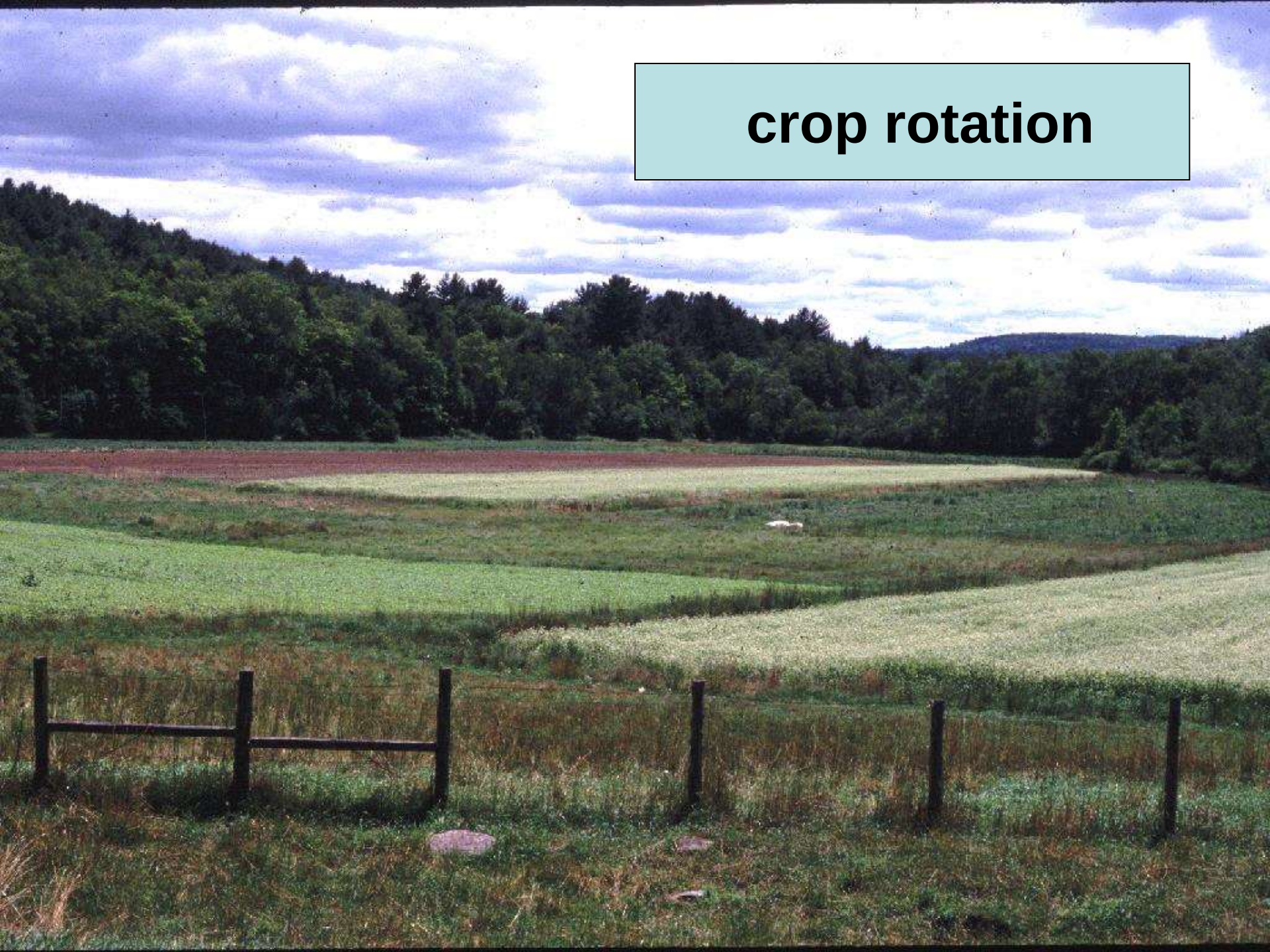
Hudak Farm



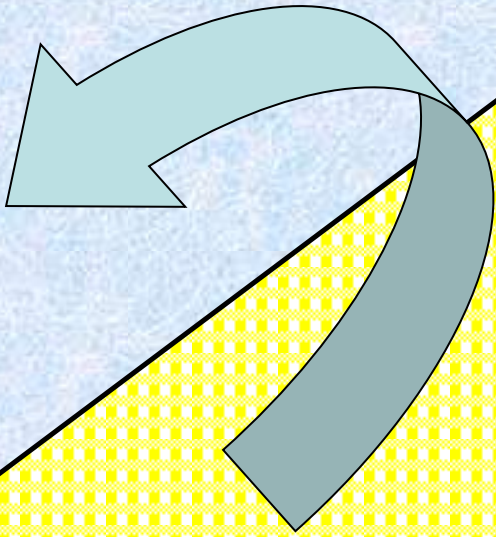
permanent wheel tracks
between rotovated strips
Blue Heron Farm, Lodi NY



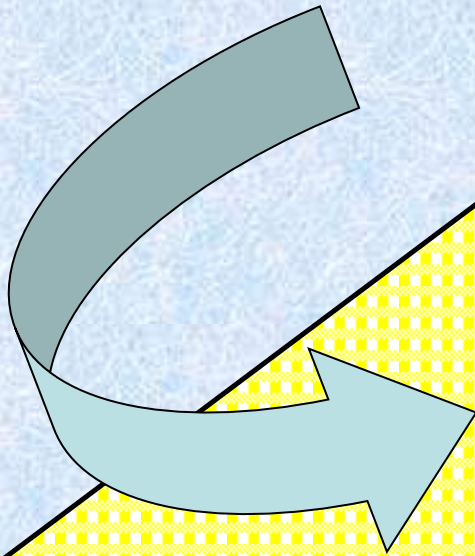
crop rotation



**Cash Crop
Rotation**



**Cover Crop
Rotation**



crop rotation guidance

Think cover crop/ vegetable alternation

Devote as much land to covers as possible.

Get a winter cover on everything

Create management units thoughtfully

Keep good records

Three rotation approaches...

...from real organic farms

2 out 3 year rotation

- **Year 1:** vegetables; rye + vetch in fall.
- **Year 2:** plow rye + vetch early summer; bare summer fallow to control weeds; oats + vetch in late summer.
- **Year 3:** plow oats + vetch in late spring; vegetables, oats + vetch in fall

Alternating years: warm/cool

- **Year 1:** plow winter rye in late spring, summer bare fallow*, oats + field peas in fall
- **Year 2:** disk oats + peas in early spring, cool-season vegetable crops; winter rye
- **Year 3:** plow winter rye in early summer, bare fallow*, rye + vetch in late summer
- **Year 4:** plow rye + vetch in late spring, warm-season vegetables; winter rye

***or buckwheat, etc.**

2 years crops / 2 years covers

	perennial weeds <i>present</i>	perennial weeds <i>absent</i>
Year 1:	<u>Vegetables</u> , fall oats that winter-kill	<u>Vegetables</u> , fall oats that winter-kill
Year 2:	buckwheat in early summer; rye and hairy vetch in fall	red clover and oats in spring, mow oats at head formation
Year 3:	plow rye/vetch in late spring; summer bare fallow; oats and field peas in fall	mow red clover 3 times
Year 4:	disk winter-killed oats/peas; <u>Vegetables</u>	plow clover in early spring; <u>Vegetables</u>

Roxbury Farm – 3 groups veggies, every other year

year 1	Oats, peas, bell beans	March 15-June 15
	Fall vegetables	July 1-Fall
	Fall vegetables	Fall-Winter
year 2	spring fallow	March 1- May 15
	sorghum sudan grass, crotalaria	May 15- Aug 15
	late summer fallow followed with oats	Sept 15- winter
year 3	Spring fallow	April 15 –June 1
	Summer vegetable crop	June1- Sept 15
	rye and hairy vetch	Oct 1 - Winter
year 4	rye and hairy vetch for straw	Winter- June 15
	summer bare fallow	June 21- July 15
	Buckwheat	July 15- Aug 30 -
	Oats and peas	Sept 15-Winter
year 5	spring fallow	March 15- April 30
	Spring and summer vegetables	April 30- Sept 30
	Oats	Sept 15- winter

Willow Pond Farm – small plots, diversified crops

Back Field - 2007

Brassicas	Cucurbits	1	Cucurbits
		2	
Roots	Greens	3	
		4	
Brassicas		5	
Roots		6	
	Greens	7	
Brassicas		8	
		9	
		10	
		11	
Greens	Roots	12	
		13	
Solanums	Flowers	14	
		15	

	Solanums
	Cucurbits
	Alliums
	Brassicas
	Roots
	Greens
	Legumes
	Perennials

Back Field - 2008

Greens	1	Early Greens	Fall Brassicas	Fall Cover Crop
	2			
	3			
	4			
Roots	5	Early Roots		
	6			
	7			
	8			
Alliums	Fall Cover Crop			
Solanums	Alliums			

Expert farmer advice:

From Planning Guide to Organic Crop Rotations

- **Do not have a 'rigid' rotation plan.**
- **Use knowledge of fields and crops, and rules of thumb that are site specific.**
- **Have contingency plans, often focused on what NOT to do.**
- **Have a clear sense of priorities.**

thank you

www.uvm.edu/vtvegandberry

