2009 Vermont Forage Conference

American Legion, Post 27

Middlebury, VT
March 10, 2009

Sponsored by
UVM Extension and USDA – Risk Management

Agenda

9:40 am	**Welcome**
9:45 am	**Maximizing Forage Nutrients to Improve Revenue Over Feed Costs** Kurt Ruppel, Regional Dairy Technology Leader, Cargill Animal Nutrition
10:45 am	**Understanding the Need for Improved Soil Quality** Bob Schindelbeck, Extension Associate, Cornell University
11:45 am	**Alternative Strategies to Increase Cover Cropping in Vermont** Roger Rainville, Owner and Operator, Borderview Farm, Alburgh, VT
12:15 pm	**Lunch**
1:10 pm	**Weed Control Considerations in Corn** Russ Hahn, Extension Weed Specialist, Cornell University
2:10 pm	**Managing Risks for Crop and Dairy Production** Jeff Carter,
2:40 pm	**Northern Corn Leaf Blight and Other Maladies** Heather Darby
3:10 pm	**The Vermont Field Crop Pest Management Program** Sid Bosworth, Extension Forage Agronomist, UVM Extension
3:25 pm	**Adjourn**

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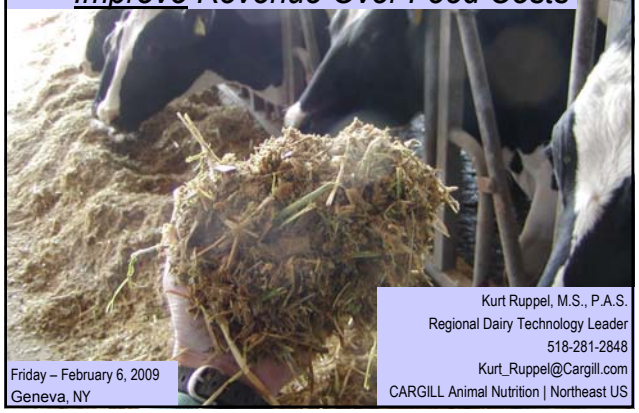
Maximizing Forage Nutrients to Improve Revenue Over Feed Costs



Kurt Ruppel, M.S., P.A.S.
Regional Dairy Technology Leader
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CARGILL Animal Nutrition | Northeast US

Friday – February 6, 2009
Geneva, NY

Take Home Message

- Cows Crave Consistency
- Maximize Forage Nutrients to Enhance NET Milk Revenue
- Cows Require Nutrients, not Ingredients
- Cows Thrive on Consistent Nutrients

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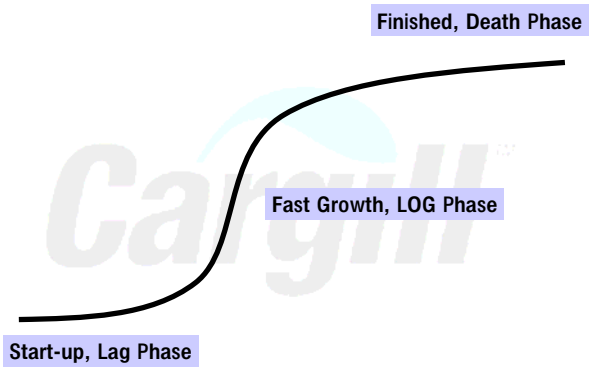
S-curve



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Feed Cost Variability - Corn

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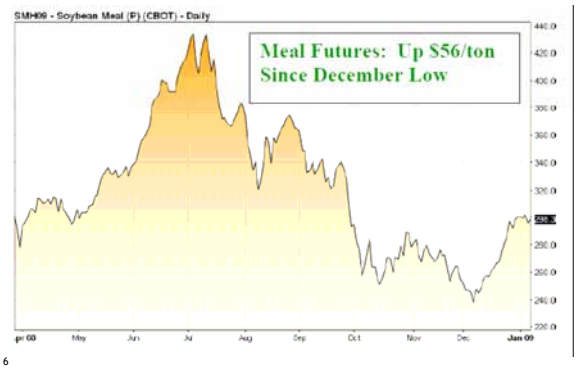
Feed Cost Variability - SBM



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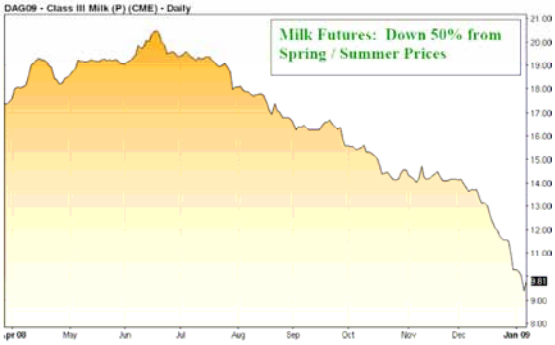
Milk Price Variability



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Milk Revenue Calculator

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Reduce Feed Cost – lose some Fat and Protein

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Milk Revenue Calculator –

Reduce Feed Cost and Not Change Production.

	"A"	"B"	Difference ("B" - "A")	
Milk Production and Pricing:				
Pounds of Milk	80	80	0.0	0%
Butter Fat Test	3.70	3.70	0.00	0%
Milk Protein Test	3.15	3.15	0.00	0%
Other Solids Test	5.70	5.70	0.00	0%
Pounds of Butter Fat	2.96	2.96	0.00	0%
Pounds of Milk Protein	2.52	2.52	0.00	0%
Pounds of Milk Fat+Prote	5.48	5.48	0.00	0%
Pounds of Other Solids	4.56	4.56	0.00	0%
Milk Fat ($/lb.)	$ 1.30	$ 1.30		
Milk Protein ($/lb.)	$ 3.64	$ 3.64		
Other Solids ($/lb.)	$ (0.03)	$ (0.03)		
Producer Price Diff. ($/c	$ (0.77)	$ (0.77)		
Volume Premium ($/cwt.)	$ 0.40	$ 0.40		
Quality Premium ($/cwt.)	$ 0.10	$ 0.10		
Other Premium ($/cwt.)	$ 0.05	$ 0.05		
Trucking ($/cwt.)	$ (2.00)	$ (2.00)		
Promotion ($/cwt.)	$ (0.15)	$ (0.15)		
Coop. Dues ($/cwt.)	$ (0.01)	$ (0.01)		
Other Deductions ($/cwt.)	$ (0.10)	$ (0.10)		
Dollars Received:				
Milk Fat	$ 3.85	$ 3.85	$ -	0%
Milk Protein	$ 9.17	$ 9.17	$ -	0%
Other Solids	$ (0.12)	$ (0.12)	$ -	0%
PPD	$ (0.62)	$ (0.62)	$ -	0%
Premiums	$ 0.44	$ 0.44	$ -	0%
Deductions	$ (1.61)	$ (1.61)	$ -	0%
Milk Value ($$/cwt.)	$ 10.64	$ 10.64	$ -	0%
Milk Value $$/cow/day	$ 10.91	$ 10.91	$ -	0%
Milk Revenue Over Feed Cost:				
Ration DM Intake per Cow	54.0	54.0	0.0	0.0
Ration Cost ($/lb. DM)	$ 0.1080	$ 0.1050	$ (0.0030)	-2.8%
Feed Eff. (3.5 Fat /3.2 Prot.	1.51	1.51	0.00	0%
Component Eff. (lbs. Fat + Pr	10.15%	10.15%	0.00	0%
Ration Cost $$/cow/day	$ 5.83	$ 5.67	$ (0.16)	-3%
Ration Cost ($$/cwt.)	$ 7.29	$ 7.09	$ (0.20)	-3%
Milk Revenue Over Feed Cost $$/cow/day	$ 5.08	$ 5.24	$ 0.16	3%
Number of Cows	500	500		
Milk Revenue - 1 week	$ 17,777	$ 18,344	$ 567	3%
Milk Revenue - 1 month	$ 77,455	$ 79,926	$ 2,471	3%
Milk Revenue - 1 year	$ 924,922	$ 954,417	$ 29,545	3%

red cells - Enter m production and pri

Enter ration intake cost below to get m revenue over feed c

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Additive Cost – per cow/day

Forage Addtive Cost Per Cow Per Day

	Forage Inclusion Rate / Cow / Day					
Per TON AF	10	20	30	40	50	60
$ 0.50	$ 0.003	$ 0.005	$ 0.008	$ 0.010	$ 0.013	$ 0.015
$ 0.75	$ 0.004	$ 0.008	$ 0.011	$ 0.015	$ 0.019	$ 0.023
$ 1.00	$ 0.005	$ 0.010	$ 0.015	$ 0.020	$ 0.025	$ 0.030
$ 1.25	$ 0.006	$ 0.013	$ 0.019	$ 0.025	$ 0.031	$ 0.038
$ 1.50	$ 0.008	$ 0.015	$ 0.023	$ 0.030	$ 0.038	$ 0.045
$ 1.75	$ 0.009	$ 0.018	$ 0.026	$ 0.035	$ 0.044	$ 0.053
$ 2.00	$ 0.010	$ 0.020	$ 0.030	$ 0.040	$ 0.050	$ 0.060
$ 2.25	$ 0.011	$ 0.023	$ 0.034	$ 0.045	$ 0.056	$ 0.068
$ 2.50	$ 0.013	$ 0.025	$ 0.038	$ 0.050	$ 0.063	$ 0.075
$ 2.75	$ 0.014	$ 0.028	$ 0.041	$ 0.055	$ 0.069	$ 0.083
$ 3.00	$ 0.015	$ 0.030	$ 0.045	$ 0.060	$ 0.075	$ 0.090
$ 3.25	$ 0.016	$ 0.033	$ 0.049	$ 0.065	$ 0.081	$ 0.098
$ 3.50	$ 0.018	$ 0.035	$ 0.053	$ 0.070	$ 0.088	$ 0.105

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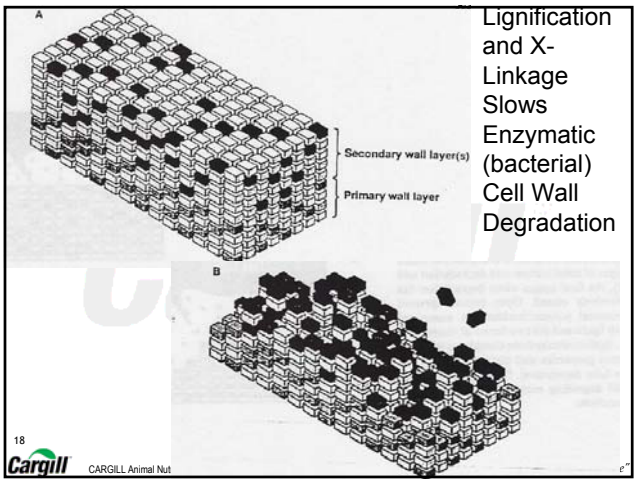
Environment and Forage Yield and Quality

P.Van Soest, Cornell Nutrition Conference, 1996

2004	Temperature	Light	Water Supply	Sum
	-	-	+	
Yield	+ -	+ -	+ +	-
Water-soluble Carbohydrate	- +	+ -	- -	-
Cell Wall	+ -	- +	+ +	+
Lignin	+ -	- +	+ +	+
Digestion	- +	+ -	- -	-



Lignification and X-Linkage Slows Enzymatic (bacterial) Cell Wall Degradation

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Defining HQF:

Live Version

Can feed more forage without compromising production.

	BW		1400			
	DMI		55			
47% Concentrate	$	0.15	25.6		$ 3.84	
53% Forage	$	0.08	29.4		$ 2.35	
1.05% BW			14.7	forage NDF pounds	**$ 6.19**	
NDF of Forage Mix			**50%**			
			1400			
	DMI		55			
41% Concentrate	$	0.15	22.3		$ 3.35	$ (0.49)
59% Forage	$	0.08	32.7		$ 2.61	$ 0.26
1.05% BW			14.7	forage NDF pounds	**$ 5.96**	$ (0.23)
NDF of Forage Mix			**45%**			

-5% NDF Change
$ (0.23) $/cow/day Change

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Why have forage in a dairy diet?

- Physical
  - requirement for effective fiber
- Nutritional
  - requirement digestible fiber
- Economic
  - Brings other nutrients along with required fiber

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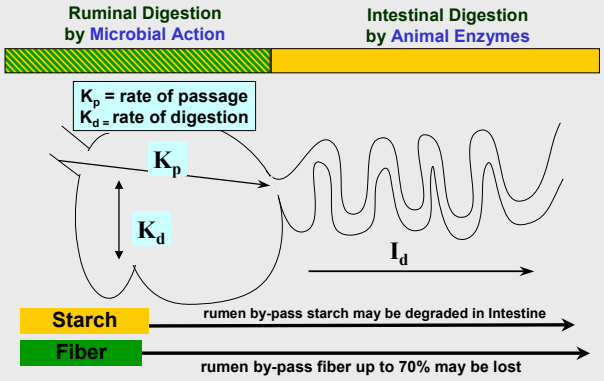
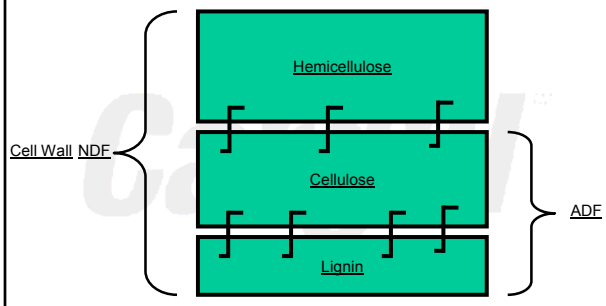
Where Digestion Occurs



ADF, NDF and NDFD



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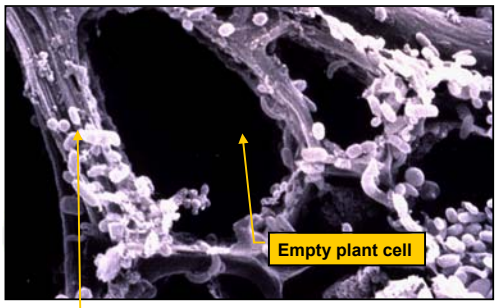
Forage at the cellular level



Sapienza – Pioneer Hi-Bred

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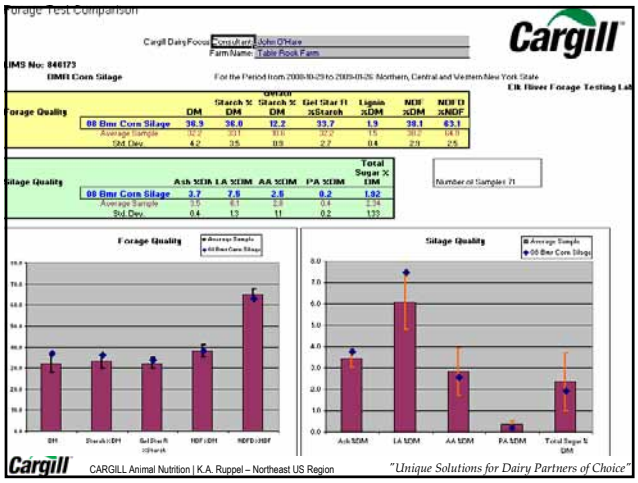

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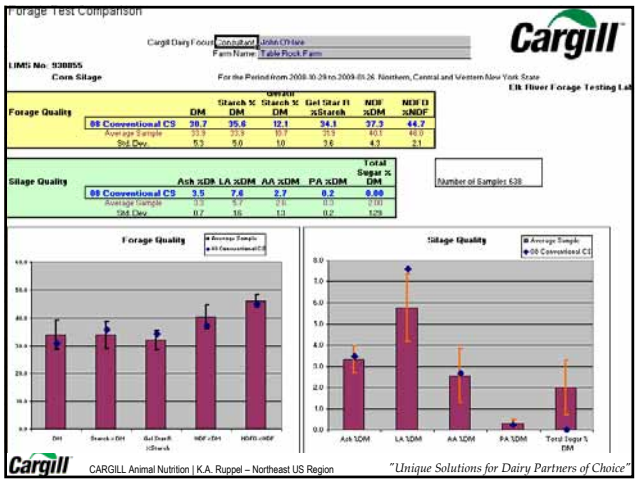

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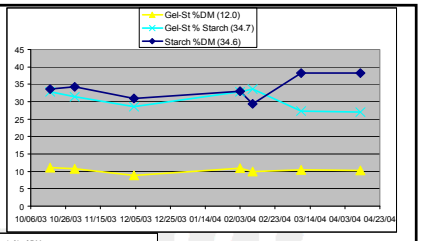
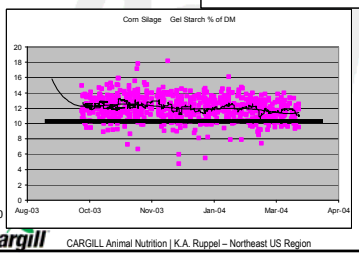
Corn Silage

Starch and Gel-Starch





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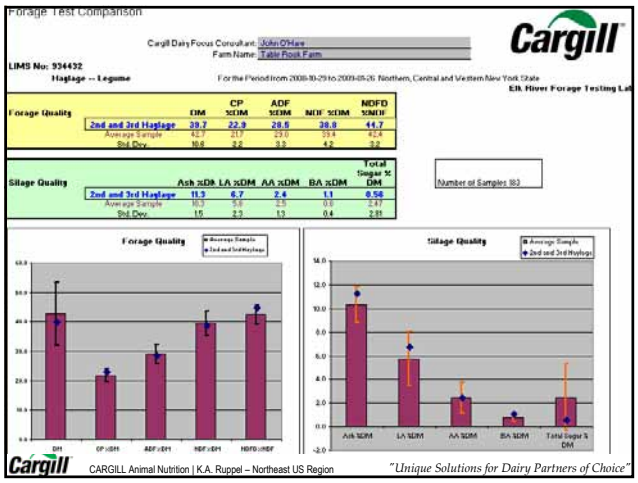

Getting and Keeping Forage Sugar

1. Maturity at Cutting
   Cell Wall : Cell Content Ratio
2. Wilting Time
   Respiration of plant sugars
3. Filling Stage of Ensiling
   Respiration of plant sugars
4. Fermentation Stage of Ensiling
   Conversion of plant sugars to VFAs
5. Feedout Stage of Ensiling
   Fungi consumption of plant sugars
6. Storage Management
   Effluent washout of plant sugars

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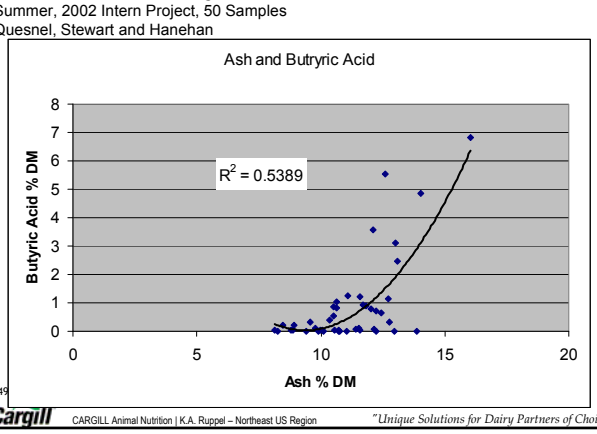
Ash and Butyric Acid

Summer, 2002 Intern Project, 50 Samples
Quesnel, Stewart and Hanehan



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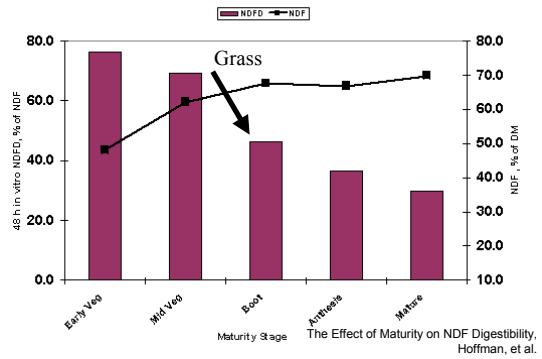
Grass Hay and Silage

Figure 1. Effect of maturity stage on 48 h NDF digestibility of grass hay and silage.



The Effect of Maturity on NDF Digestibility, Hoffman, et al.

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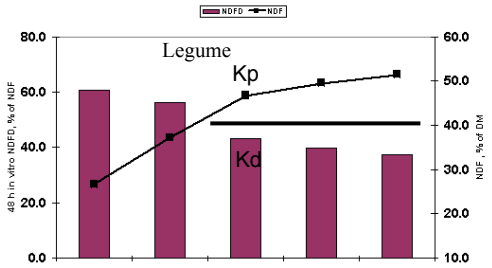
Legume Hay and Silage

Figure 2. Effect of maturity stage on 48 h NDF digestibility of legume hay and silage.



Plant Morphology does not predict quality

Maturity Stage

The Effect of Maturity on NDF Digestibility, Hoffman, et al.

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Using **Alfalfa Plant Height** to Trigger Cutting of Pure and Mixed Alfalfa-Grass Stands – Jerry Cherney, Cornell Univ.

When Alfalfa near the Grass field is 15 inches tall	Start to Cut Your Pure Grass Stands
When Alfalfa in Mixed 50%Alfalfa 50% Grass Stands is 24 inches tall	Cut Your Mixed Stands
When Alfalfa is 30 inches tall in nearly Clear Alfalfa	Cut Your Mostly Alfalfa Stands

15" – 24" – 30"

Optimize Milk Per Acre

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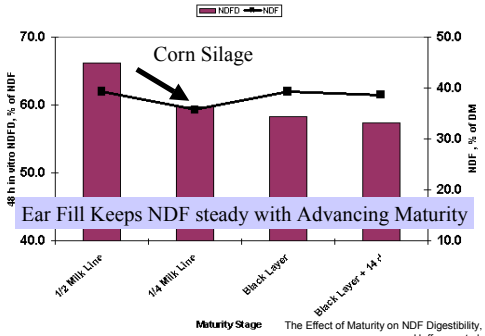
Corn Silage

Figure 3. Effect of maturity stage on 48 h NDF digestibility of corn silage.



Ear Fill Keeps NDF steady with Advancing Maturity

Maturity Stage

The Effect of Maturity on NDF Digestibility, Hoffman, et al.

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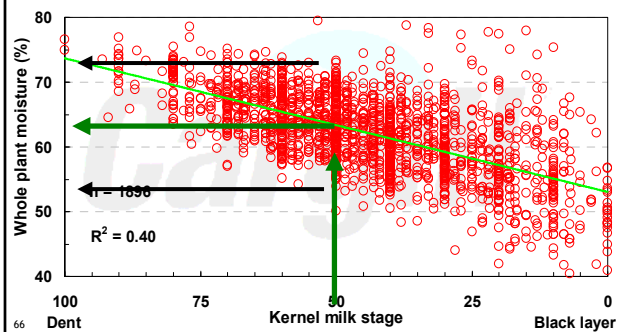
Relationship between whole plant moisture and kernel milk stage (1990 - 1999)



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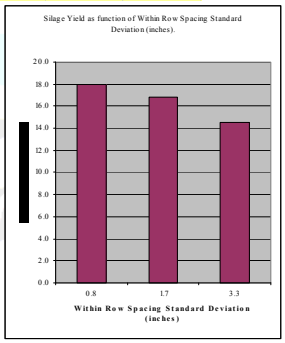
Agronomic Effects on Forage Yield

Plant Pop	Row Spacing - Inches	Within Row Spacing - Inches
30,000	30	7.0

	7	7	7
	6	5	3
	8	9	11
	7	7	7
	6	5	3
	8	9	11
	7	7	7
	6	5	3
	8	9	11
	7	7	7
	6	5	3
	8	9	11
	7	7	7
	6	5	3
Average	6.9	6.9	6.7
SD	0.8	1.7	3.3
Yield	18.0	16.8	14.5



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"High Chop" Corn Silage

Greg Roth and Zhiguo Wu - Observations and Data on Corn Chop Height Effects

Average nutrient content and production of corn silage harvested at low or high levels of height (summarized from 11 studies[1]).

Item	Low Height (6.8 +/- 2.5")	High Height (19.3 +/- 2.8")	Change (%)
DM, %	38.1	40.3	5.8
CP, %	7.0	7.1	1.4
ADF, %	24.2	21.8	-9.9
NDF, %	41.6	38.6	-7.2
Starch, %	30.0	32.4	8.0
NEL, Mcal/lb	0.71	0.74	4.2
NDFD invitro, % of NDF	50.6	54.0	6.7
NDFD invitro, % of DM	21.0	20.8	-1.0
DMD invitro, %	78.6	80.6	2.5
Yeild, ton/ac, DM	8.1	7.5	-7.4
Milk Equiv., Milk 2000			
lb/ton	3014	3162	4.9
lb/ac	20990	20610	-1.8

1/ Antos, 2002; Cox, 2003; Curran and Posch, 1999; Cusicanqui, 1998; Dominquez, 2002, 2003; Neylon and Kung, 2003; Petzen, 2000; Sass, 1996; Shirk, 2001; Wu, 2001; not all studies reported all measurements.

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How do we get the most out of BMR Corn Silage?

- Grow and Store it separate from other corn silage.
- Feed heaviest to Transition Cows, then high producers.
- Work % Forage up quickly.
- Support rumen fermentation with rumen available CHO and protein.
- Fermentation Challenge – acts wetter than it is.
- Watch Sugar Values – may cause heating.
- Watch Starch Values – can be higher and less available than expected.

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Physical Composition

Speed-Up Chopping	**Long**
Enhance Ensiling	Short
Improve Rumen Health	**Long**
Prevent Sorting	Short
Increase Intake	Short
Slow Rate of Passage	**Long**
Improve Ration Digestibility	Short

- Trying to accomplish many things with Diet Particle Size Distribution.

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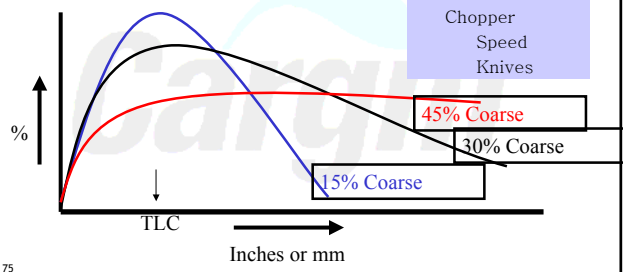
Forage particle length distribution and Chopper TLC

Factors
- Moisture
- Species
- Volume
- Initial Length
- Chopper
  - Speed
  - Knives



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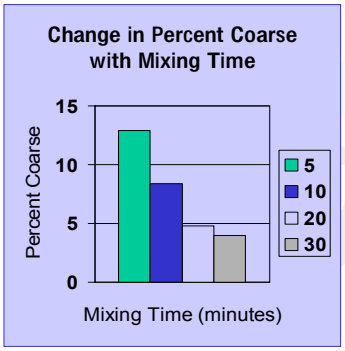
TMR Mixing Time and Effective Fiber

Cornell University T & R Center, Batchelder and Chase, 1998



Find the ideal mixing time and put a "watch to it" every feeding.

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TMR Particle Size Calculator

End

Cargill Animal Nutrition — *TMR and Forage Particle Size Distribution Calculator*

(c) K.A. Ruppel 2002 CAN v3.075

Enter ration ingredient and TMR information

Ration: Ingredient	DM	DM pounds	As Fed Pounds	AF Percent TMR	DM Percent Forage	Particle Distributions: TOP Coarse	MIDDLE Medium	BOTTOM Fine	ck	Theoretical TMR: TOP Coarse	MIDDLE Medium	BOTTOM Fine
Reg Corn Silage	31%	18.0	57.9	51%	62%	9%	70%	21%	100%	5%	36%	11%
BMR CS	30%		0.0	0%	0%	5%	69%	26%	100%	0%	0%	0%
1st HCS Trench	34%		0.0	0%	0%	18%	55%	27%	100%	0%	0%	0%
All Agbag	45%	10.0	22.2	20%	35%	25%	50%	25%	100%	5%	10%	5%
Oat Straw	89%	0.9	1.0	1%	3%	95%	5%	0%	100%	1%	0%	0%
		28.9	81.1		100%							
Cotton	89%	3.0	3.4	3%		0%	95%	5%	100%	0%	3%	0%
Beet Pulp	89%	2.7	3.0	3%		50%	50%	0%	100%	1%	1%	0%
Pellets	90%	9.5	10.6	9%		0%	10%	90%	100%	0%	1%	8%
Meal	90%	13.0	14.4	13%		0%	0%	100%	100%	0%	0%	13%
		28.2	31.4	100%		Projected ==>			100%	12%	51%	37%
	Total	57.1	112.5									
	basis	AF	DM									
Percent Forage		72%	51%									
TMR % DM		51%										

High TMR	Actual	100%	9%	45%	46%
	GOAL	100%	8%	55%	37%

Theoretical TMR particle distribution is calculated, compare to your Goal and the Actual TMR.

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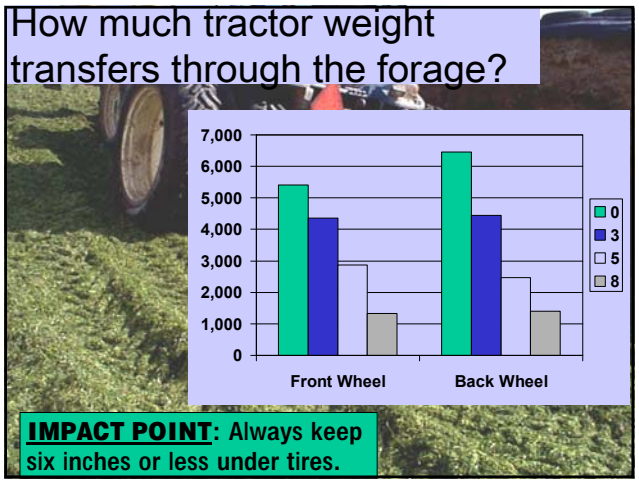
Bunker Silo Density

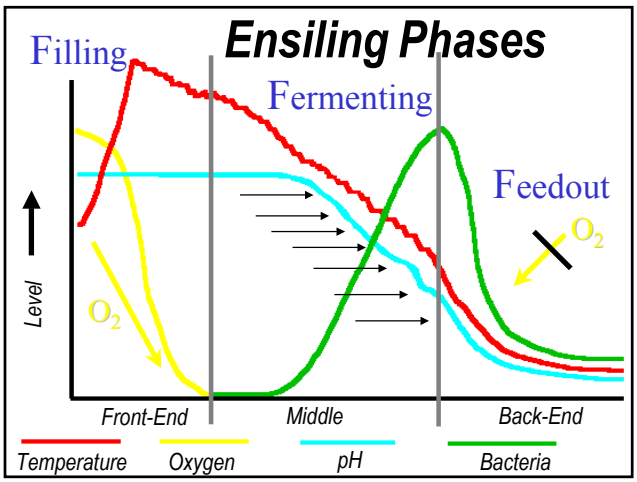
effect of Depth, Layer Thickness and Packing Weight[1]

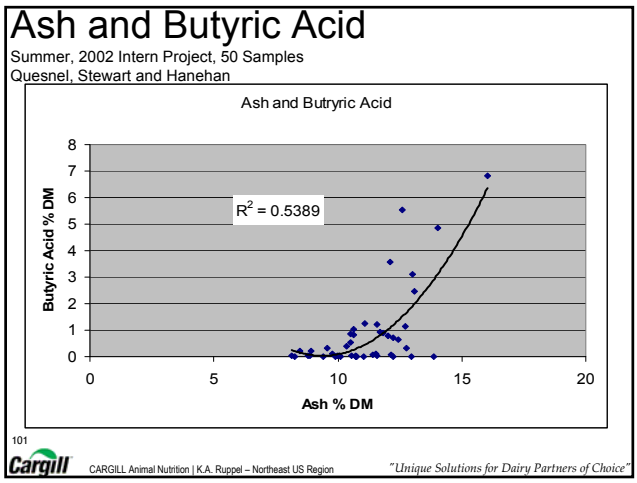
Silo Depth	Silage Layer	Tractor Packing 70K	50K	30K	
	hr-lbs/ton	1000	714	429	
8'	6"			11.5	+15%
12'	6"			12.0	+34%
16'	6"			12.8	+27%
					+12%
8'	12"	12.1	10.9	9.7	
12'	12"	12.8	11.5	10.2	
16'	12"	13.5	12.1	10.8	+11%

83

[1] Chopped at **70 tons per hour**; adapted from Muck and Holmes (1999), by Ruppel.


How much tractor weight transfers through the forage?
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
Front Wheel
Back Wheel
0
3
5
8
IMPACT POINT: Always keep six inches or less under tires.


Ensiling Phases
Filling
Fermenting
Feedout
O_2
O_2
Level
Front-End
Middle
Back-End
Temperature
Oxygen
pH
Bacteria


Ash and Butyric Acid
Summer, 2002 Intern Project, 50 Samples
Quesnel, Stewart and Hanehan
Ash and Butyric Acid
$R^2 = 0.5389$
Butyric Acid % DM
Ash % DM
0
1
2
3
4
5
6
7
8
0
5
10
15
20
101
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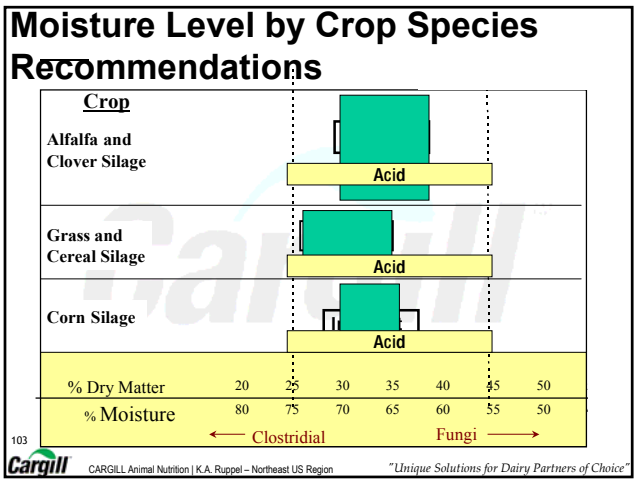
Moisture Level by Crop Species
Recommendations
Crop
Alfalfa and Clover Silage
Grass and Cereal Silage
Corn Silage
Acid
Acid
Acid
% Dry Matter
20 25 30 35 40 45 50
% Moisture
80 75 70 65 60 55 50
Clostridial
Fungi
103
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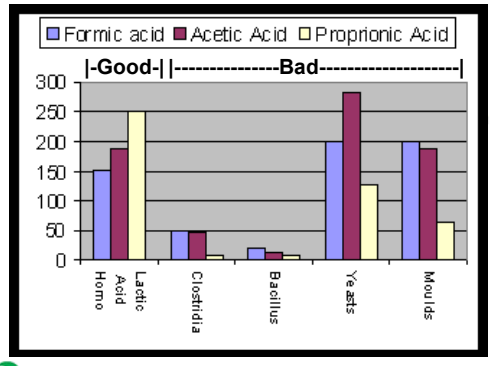
Acid effects on initial microbes

- McDonald, et al.



109

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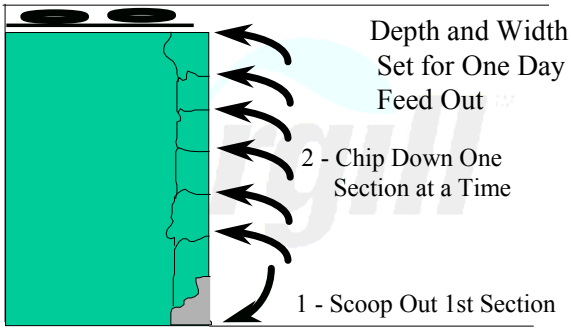
Face Management

End



119

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Limits O_2 Penetration 20X better than regular plastic.

SS.ppt

TEST	Silostop	Reg. cover
Thickness (mil)	1.8 or 5	5
Permeability to oxygen ($cm^3/m^2/24h$)	100	2000

Silostop 1-step, sealed and weighted with Silostop gravelbags

138

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How many rations on the farm?

1. On paper.
2. Mixed together.
3. Delivered to cows.
4. Consumed by cows.
5. Digested by cows.

153

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How many rations on the farm?

1. On paper.
2. Mixed together.
3. Delivered to cows.
4. Consumed by cows.
5. Digested by cows.

How many *Sets of Nutrients* on the farm?

154

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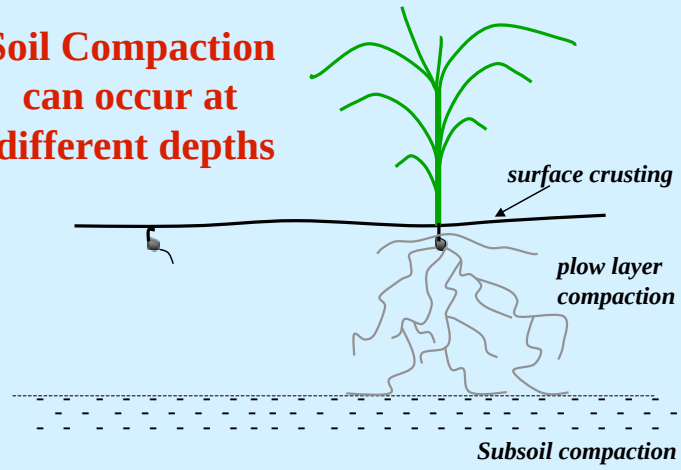
Understanding the Need for Improved Soil Quality when Transitioning to Reduced Tillage Systems

Cornell University
College of Agriculture and Life Sciences
Department of Crop and Soil Sciences
Bob Schindelbeck
Extension Associate
rrs3@cornell.edu
soilhealth.cals.cornell.edu

Soil Compaction can occur at different depths



Conceptualization of "addiction to tillage"

Intensive tillage, soil erosion and insufficient added residues

Soil organic matter decreases

Aggregates break down

Erosion by wind and water increases

Surface becomes compacted, crust forms

More soil organic matter is lost

Less soil water storage, less diversity of soil organisms, fewer nutrients for plants

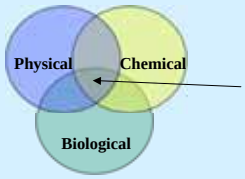
Crop yields decline

The downward spiral of soil degradation

Modified from Topp et al., 1995

Corn Silage Yields (Tons/A)

	2007		2008	
	No N	100# N	No N	100# N
Plow till	7.1	12.4	7.2	12.8
No till	11.1	17.4	15.3	19.8

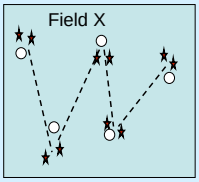


Soil Health Philosophy:
A healthy soil is a balanced system that provides for crop resiliency to stress. We can optimize our soil management by measuring soil indicators to identify constraints.

Characteristics of Healthy Soil

- ***Physical*** **- good tilth for optimal root growth, good water infiltration, water storage; STRUCTURE**
- ***Biological*** **- low pest populations, fully functional species important in nutrient cycling and producing plant growth stimulating compounds; ACTIVITY, CYCLING**
- ***Chemical*** **- adequate levels of available nutrients-but not too high; optimal pH for crop rotation; low levels of toxic or disruptive substances–Al, salts, Na; NUTRITION**

Soil Sampling- Early spring



Mix and subsample

Sample size is 6 cups (about 3 pounds)

Cost (2009) is $60 / sample

Wet aggregate stability

Available water capacity

Field penetration test

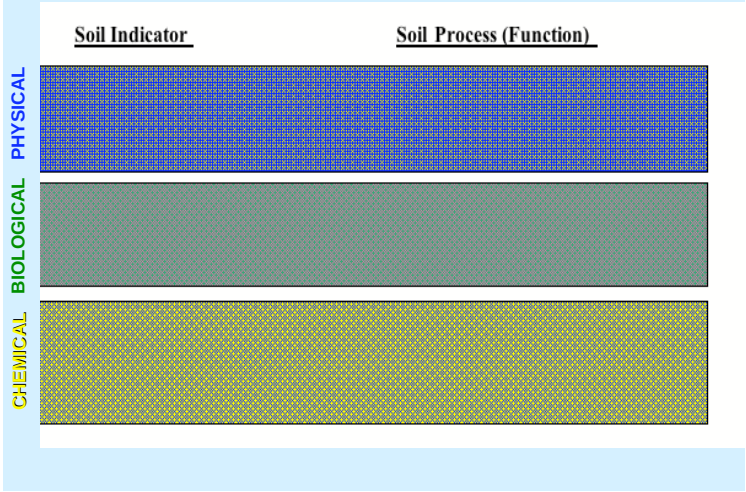
Some analyses in the Cornell Soil Health Test

Active carbon test

Potentially Mineralizable N

Root Health rating

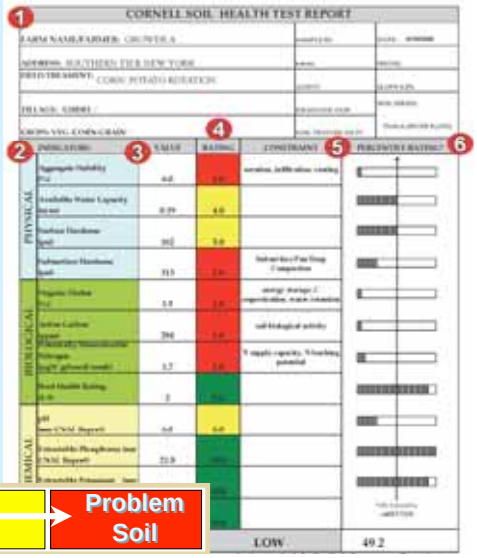
Soil Health Indicators



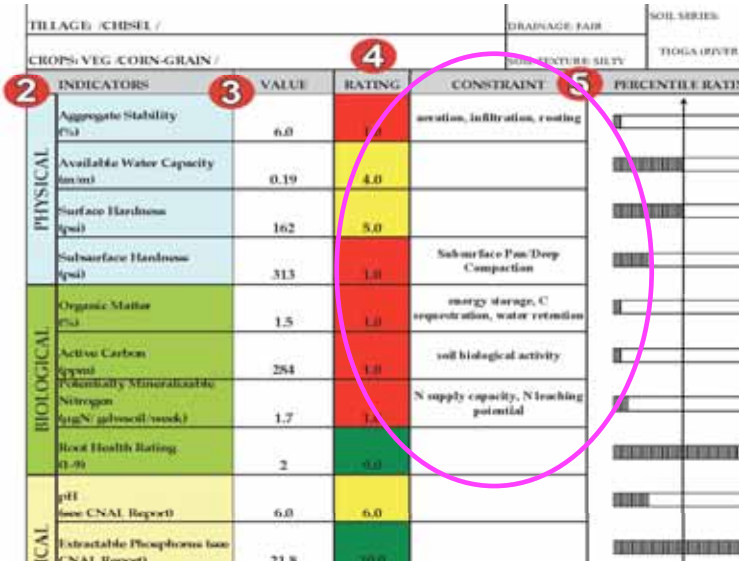
SOIL HEALTH TEST REPORT

4- RATING with interpretive color code (grouped by texture)

5- CONSTRAINT- affected soil function



Healthy Soil ↔ Problem Soil



Linking Indicators to Management

LOW AGGREGATE STABILITY:
short-term: integrate shallow-rooted cover or sod-rotation crops, add manures
long-term: reduce tillage intensity

LOW AVAILABLE WATER CAPACITY:
short-term: add stable organic matter (e.g. compost)
long-term: reduce tillage intensity

HIGH SURFACE DENSITY:
short-term: localized physical soil loosening (e.g., strip tillage); frost tillage, cover crops and organic matter additions
long-term: integrate shallow-rooted cover or rotation crops; avoid traffic on wet soils; use controlled traffic lanes

HIGH SUB-SURFACE HARDNESS:
short-term: targeted physical soil loosening at depth (e.g., zone building, ripping, strip tillage); integrate deep-rooted cover crops
long-term: avoid moldboard plows and disks that generate tillage pans; reduce equipment loads; avoid heavy equipment traffic on wet soils

Linking Indicators to Management (cont'd)

LOW ORGANIC MATTER and LOW ACTIVE CARBON:
Short-term: integrate cover or sod rotation crops; add manure or compost
long-term: reduce tillage

LOW POTENTIALLY MINERALIZABLE NITROGEN:
Short-term: add N-rich organic matter (not excessive); use leguminous cover or rotation crops
long-term: reduce tillage

HIGH ROOT ROT RATING:
use proper rotations, cover crops and/or appropriate chemical and biological control products

LIMITING LEVELS OF pH OR NUTRIENTS: see CNAL recommendations

The Soil Health Management Toolbox

1. **Reducing or modifying Tillage**
2. **Crop Rotation**
3. **Growing cover crops**
4. **Organic/ chemical amendments**

Ex. Reduce tillage by changing tillage depth, implement used, number of passes, timing of use, use of no-till planter

Crop rotation could include a shorter-season variety to open a window for another seeding

Cover crop could be legume or grass, summer or fall establishment

Fresh manure versus composted, quality of composted debris

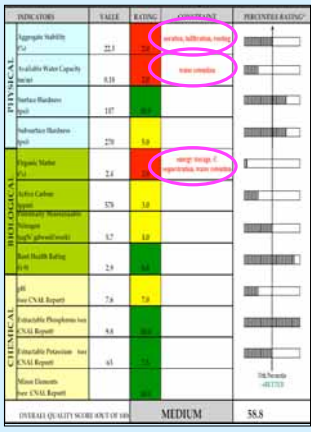
The Soil Health Management Toolbox
Grain crop systems

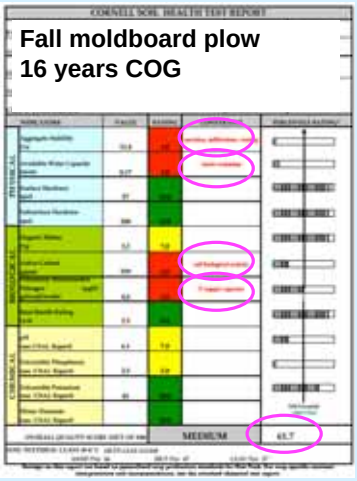
- **Reducing or modifying tillage**
  Fields managed for top grain crop production are well suited to reduced tillage/ planting systems
  Heavy harvesting equipment in the field can compact surface and subsurface soil layers- consider deep ripping strategies
  No-till drilling of grain crops reduces soil disturbance and saves operator time
- **Crop rotation**
  Choosing shorter-season crop varieties may open planting windows for short season cover crop (green manure) establishment
- **Growing cover crops**
  Common goals for green manures are to provide Nitrogen, reduce soil erosion provide weed control, improve soil structure, furnish moisture-conserving mulch
- **Organic amendments**
  Identify windows for application of on- or off-farm sources of manure and composts
  Note that 'fresher' green and animal manures provide both nutrients energy-rich food for microorganisms living in the soil. Breakdown products help to 'glue' soil particles together to increase soil tilth
  More stable composts can lighten heavier soils and add water and nutrient storage capacity to coarser soils

The Soil Health Report is a management guide, not a prescription

Flexibility is the framework for adapting the Report information to a management strategy to fit **your** field/ farm

- Different management approaches can solve the same problem
- A single management practice can solve several problems
- Draw on information from other sources- field days, workshops, local "success stories", etc





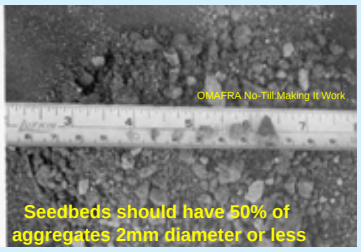
Fall moldboard plow
16 years COG

No-till (one-pass planting)
16 years COG

Cornell University E. V. Baker Farm, Willsboro, NY
Kingsbury clay loam, 16 years continuous corn for grain

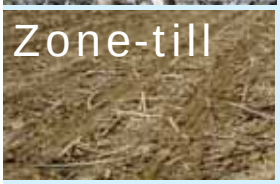
Tips for transitioning to reduced tillage crop production

- **Soil loosening** is the first step in alleviating any soil compaction ***SHORT TERM***
- Reduced tillage soils are less susceptible to compaction and more resilient due to better soil aggregation ***LONGER TERM***
- Soil structure is additionally improved through **cover crops, rotation, and fresh organic additions** ***LONGER TERM***
- When severe compaction has occurred reduced tillage systems will benefit from soil loosening. i.e., the cost of **tillage** is outweighed by the benefits of soil loosening ***SHORT TERM***
- When limited compaction has occurred, **zone building or strip tillage** will suffice
- Rebuild beneficial microbial communities by **feeding the soil** food web



No-till drill

Single-pass planting systems

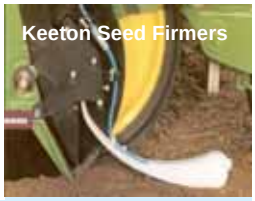


Advantages of single-pass planting systems

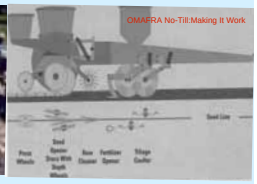
- **ECONOMIC (fuel and labor)- Reduce energy use and number of field operations (each trip across costs about $10/A)**
- **TIMING- Avoids working up wet soil between operations- *put seed in the ground* when surface has dried off**

These are single-pass planting systems

No-till drill



Kinze zone-till planter

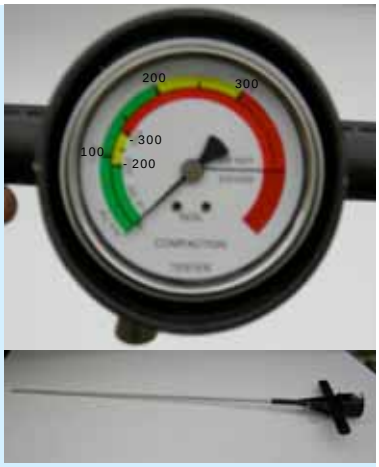


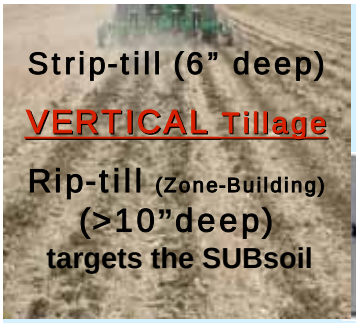
- These single pass planting systems rely on high levels of operator skill
- **Lighter soils, healthy soils respond best to these methods**
- Work with local 'experts' to gain locale-specific insights
- Look for inexpensive new technologies to fine-tune systems

Where is the compaction?

MEASURING PENETRATION RESISTANCE

Spade

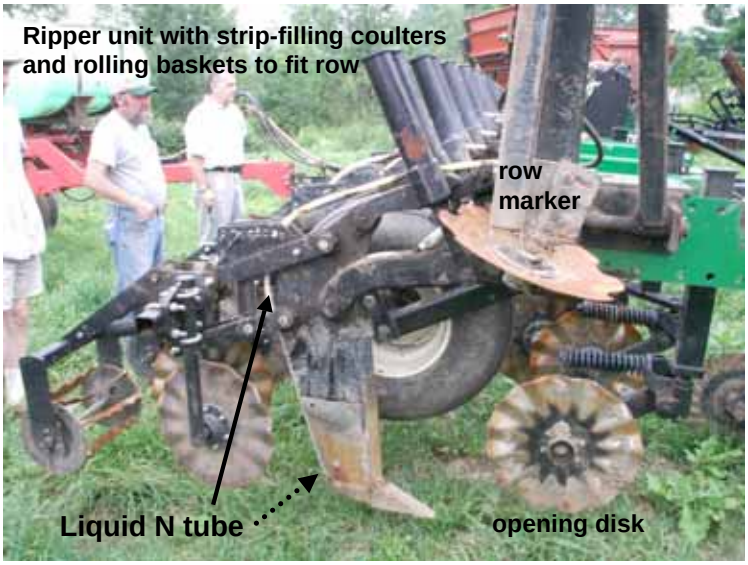




Multiple–pass planting systems using a Ripper unit for primary (VERTICAL) tillage

Focused disturbance ***only in the row-*** move residues to the interrow area

Conventional planter follows ripped strips



Costs in dollars and time for row crop field operations (2008)[1]

Tillage/planting system	dollars per Acre	hours per Acre	speed compared to conventional
Zone-till ONE pass planting	9	0.17	2.9
Strip till row crop Rip-till (zone-building) row crop	20	0.27	1.8
Zone-Building row crop (deep rip, zone-till plant)	27	0.33	1.4
Conventional row crop (moldboard, disk, finish, plant)	35	0.48	1.0

** Lazarus and Seeley, Univ. of Minn Extension*

- *Borrow or rent new equipment to find the match for a field or farm*
- *Set out 'strip trials' to test equipment, cover crops*
- *Collect soil samples for Cornell Soil Health Test to highlight management targets*
- *Re-build soil health before trying reduced tillage "cold turkey"*

Reduced Tillage Lessons Learned

Transition awareness from "tillage addicted" soils

- Lighter soils and dry springs contribute to reduced tillage success
- Successful adoption of restricted-width tillage systems requires excellent soil management skills/ ability to innovate
- Degraded soils need soil compaction relief BEFORE conversion to reduced tillage (soil is addicted to tillage)
- Degraded soil problems (poor structure) are most obvious in extreme years

Intermediate technology (to deal with compaction)

- Trash wheels on planting units and coulters on planter frame benefits seedbed prep. **(zone-till)**, germination and seedling establishment
- Matched cultivator to clear residue **(strip-till** or **deeper zone-building)** increases seedbed loosening and soil warming for earlier planting

Soil health testing to guide management

- Soil structure can be restored through targeted compaction relief, drainage, crop rotation, organic additions, changes in management strategies
- Healthy soil structure increases soil resiliency- soil is less prone to compaction, traffic damage is less severe

Cornell University
Cooperative Extension

The Link Between Soil Health and Reduced Tillage

WHAT'S CROPPING UP? VOLUME 18, NUMBER 3, MAY-JUNE, 2008

In a recent article "How to Interpret and Use the Cornell Soil Health Test (CSHT) Report" in What's Cropping Up? (Vol. 18 No. 1, Jan.-Feb. 2008), we noted that modifying tillage can be part of targeting soil health constraints. Typically, reduced tillage systems are part of a 'management transition' that includes correction of compaction issues and establishment of cover crops and/or application of animal manures. Reduced tillage for row crops can offer advantages in terms of reduced labor and fuel costs, improved timeliness of planting, and enhanced soil health. By minimizing soil disturbance we can also reduce weed seed germination and maintain a buffered environment for soil organisms by keeping plant debris on the soil surface. Other noted advantages are protection of soil organic matter, conservation of water, and reduction of erosion. However, some growers have reported failures from 'cold turkey' switches to eliminating tillage in degraded soils that are in poor health. These fields lack environmental resilience due to inadequate soil structure, depressed biological activity and/or reduced nutrient availability. The success of a reduced tillage system depends on identifying limiting factors to crop growth and substituting soil-building practices that improve soil health. With that, recognize that implementing reduced-tillage soil management strategies on a healthy soil is inherently easier than on a degraded soil.

CORNELL SOIL HEALTH TEST REPORT

Case Study A

Corn for grain since 1999
Plow till, disk 2X
Clay loam

	INDICATORS	VALUE	RATING	CONSTRAINT
PHYSICAL	Aggregate Stability (%)	54.5	8.0	
	Available Water Capacity (m/m)	0.21	4.0	
	Surface Hardness (psi)	246	1.0	rooting, water transmission
	Subsurface Hardness (psi)	400	1.0	Subsurface Pan/Deep Compaction
BIOLOGICAL	Organic Matter (%)	4.2	6.0	
	Active Carbon (ppm)	441	1.0	soil biological activity
	Potentially Mineralizable Nitrogen (µgN/gdwsoil/week)	11.2	7.0	
	Root Health Rating (1-9)	2.7	9.0	
CHEMICAL	pH (see CNAL Report)	6.8	10.0	
	Extractable Phosphorus (see CNAL Report)	6.0	10.0	
	Extractable Potassium (see CNAL Report)	63	7.5	
	Minor Elements (see CNAL Report)		10.0	
	OVERALL QUALITY SCORE (OUT OF 100)		MEDIUM	62.1

PERCENTILE RATING*

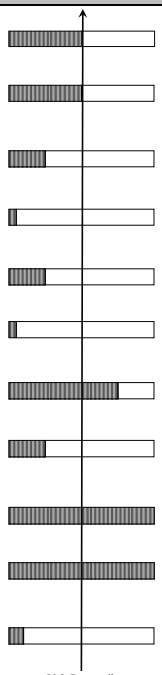


Figure 1. An example of a Cornell Soil Health Test Report.

With the Cornell Soil Health Test, we can approach soil management from an integrative perspective where we measure the physical, biological and chemical properties of field soils with the Cornell Soil Health Test (What's Cropping Up?, Vol. 17 No.1). The test identifies constraints that we link to remedial soil management practices. If multiple constraints are present, a good selection of management practices can address several issues simultaneously. A typical Cornell Soil Health Test Report from a long-term research farm trial on a clay soil is shown as Case Study A in Figure 1. This example field has high soil hardness in the surface (0-6") and subsurface (6-18") horizons. A low value for active carbon indicates a reduced energy supply for soil biological activity. The effects on soil health parameters from 8 years of moldboard plowing and disking to grow corn for grain have been revealed. These limitations can be targeted with our soil management planning. Our revised soil management system for this case should incorporate soil compaction relief (including the subsoil) and the integration of a rotational crop or green manure.

Successful reduced-tillage crop production is part of a soil management system:

1. Identify the limiting factors (constraints) to crop growth (measure)
2. Implement soil-building practices (modify tillage, changing crop rotations, using cover crops and adding organic amendments) that improve overall soil health
3. Use enhanced tillage practices and equipment technologies (move forward)

Reduced Tillage Systems for Row Crop Production

Most reduced tillage systems are best conceptualized as restricted-width tillage systems, in contrast to full-width conventional plowing. Reduced tillage focuses the soil disturbance on a zone where the seed will be placed. Most growers report that starting small and working with local experts helped them implement inexpensive adjustments to fine-tune their system. Renting or borrowing equipment that has been used with success on similar soils can help find the match for a particular field or farm. Avoid difficult fields when learning the basics of new equipment.

Single Pass No-Till and Zone-Till Systems

No-till grain drills and coulter-equipped row crop planters (zone-till planter) are used in single-pass soil preparation and planting systems. This equipment represents the extreme in reducing soil disturbance for seed placement. Savings in fuel and operator time, as well as enhanced timeliness of planting, are maximized with these systems. Such systems are not recommended if the soil health test identifies low aggregate stability and high surface and subsurface compaction layers that restrict root growth and water movement in the soil profile. Such restrictions can limit the success of single-pass planting systems, because the soil remains hard and dense. No-till may be more successful after soil health has been improved through sod rotations, cover crops and organic matter additions, perhaps combined with gentle tillage tools like an Aerway, spader, or Smart-Till.

Multiple Pass Zone Builder and Strip Till Systems

There are several tillage options that overcome the compaction concerns, yet provide soil health benefits similar to no-till. The Zone Builder Tillage System involves the use of a sub-soiler (Figure 2a) as a primary tillage tool. It is recommended if the soil health test identified problems with surface and subsurface compaction. The straight leg shanks can 'rip' vertical slots in the soil to a depth of up to 18 inches, thereby allowing deep rooting. The appropriate depth to

Figure 2a. Zone Builder sub-soiler shanks can rip soil down to 18" deep.

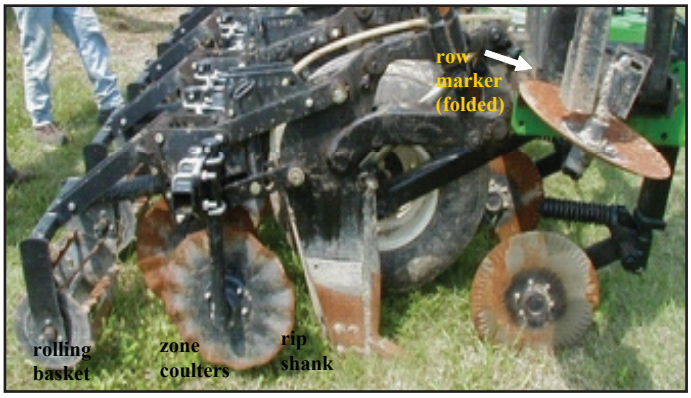


Figure 2b. Zone Builder System with rip shank, coulters and finishing baskets. Note that the folded row marker is used for both Zone Building and planting.

operate the tool is 2 inches below the bottom of the restrictive layer, and the soil at that depth should be sufficiently dry (friable). We recommend the use of a soil penetrometer or compaction tester, used when the soil is at field capacity, to identify the depth of the restrictive layer. When sampling for the Cornell Soil Health Test, the compaction layer is measured as part of the protocol. A tile probe (Figure 3) or spade-dug hole may also be used to verify the depth and thickness of the dense layer across the field.

As the sub-soiler moves across the field, the 6-8 inch wide seeding zone is built as the deep soil loosening is combined with zone-defining coulters and rolling baskets (Figure

2b). This 'vertical tillage' and conditioning of the loosened soil provides a fit soil strip for subsequent planting. Growers match the widths of the sub-soiler with their conventional row crop planters to plant directly on these prepared strips. Zone building may not need to be repeated every year if care is taken to prevent re-compaction of the soil. Some farmers have used the tool several years in a row, going cross ways in different years, and then decided to use it only once in awhile after that.

If the soil health test only identified problems with compaction in the surface layer, then strip tillage may be a good choice. Like the zone builder, it creates a narrow zone where the soil is ripped, but the tool only goes down to about 8 inches. Strip tillage is generally done on an annual basis in the fall or spring.

More information on the adaptability ratings of tillage systems and soil management issues is available in the 2008 Cornell Guide for Integrated Field Crop Management. Also, detailed descriptions of reduced tillage machinery are available as Fact Sheets from the Reduced Tillage website at http://www.hort.cornell.edu/reducedtillage/

Figure 3. Soil compaction tester used to determine depth to a restrictive (dense) soil layer

Cost and Efficiency

The costs of field operations will vary depending on equipment, fuel and labor costs. Table 1 presents fuel and labor costs for the reduced tillage systems mentioned above versus a conventional moldboard system. One-pass zone till planting requires one-third the labor hours as a four-pass conventional system, and the total cost is only one quarter. The 2-pass zone builder system is 40% faster than the conventional system, but only realizes a 25% savings from conventional due to the higher power requirements for the deep zone building. With high energy costs, reducing fuel consumption therefore greatly benefits the bottom line.

Table 1. Costs in dollars and time for row crop field planting operations. W. Lazarus (2008). University of Minnesota Extension Service.

Tillage/planting system (row crop)	dollars per Acre	hours per Acre	speed compared to conventional
Zone-till (one-pass planting)	9	0.17	2.9
Zone Builder System (deep rip, zone-till plant)	27	0.33	1.4
Conventional (moldboard, disk, finish, plant)	35	0.48	1.0

Robert Schindelbeck, John Idowu, Harold van Es, Department of Crop & Soil Sciences, Cornell University

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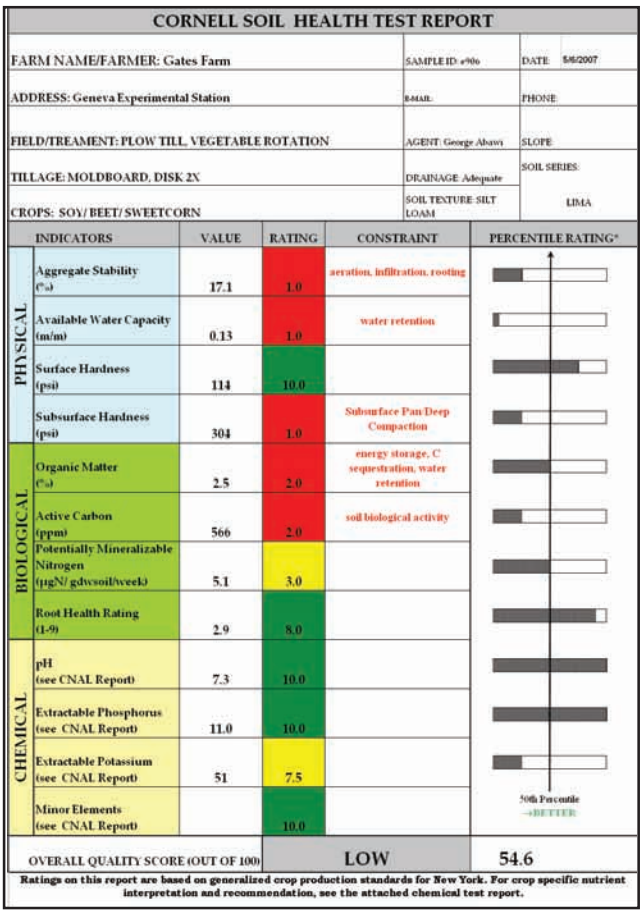
2008

Cornell University Cooperative Extension

How to Interpret and Use the Cornell Soil Health Test Report

WHAT'S CROPPING UP? *VOLUME 18, NUMBER 1, JAN. - FEB., 2008*

Since 2003, the Cornell Soil Health Team has been working to develop an integrative approach to soil management by measuring soil physical, biological and chemical properties. This strategy was previously discussed in 2006 in What's Cropping Up?, Vol. 16 No. 2 & No. 3. We introduced the new Cornell Soil Health Test (CSHT) in early 2007 (What's Cropping Up?, Vol. 17 No. 1) to the public as a fee-for-service analysis. Here, we discuss the interpretation of the Cornell Soil Health Test Report to facilitate better soil management. For many, much of this information is new, and we will discuss approaches to maximizing its utility.



CORNELL SOIL HEALTH TEST REPORT

FARM NAME/FARMER: Gates Farm	SAMPLE ID: e906	DATE: 5/6/2007
ADDRESS: Geneva Experimental Station	E-MAIL:	PHONE:
FIELD/TREAMENT: PLOW TILL, VEGETABLE ROTATION	AGENT: George Abawi	SLOPE:
TILLAGE: MOLDBOARD, DISK 2X	DRAINAGE: Adequate	SOIL SERIES:
CROPS: SOY/ BEET/ SWEETCORN	SOIL TEXTURE: SILT LOAM	LIMA

	INDICATORS	VALUE	RATING	CONSTRAINT
PHYSICAL	Aggregate Stability (%)	17.1	1.0	aeration, infiltration, rooting
	Available Water Capacity (m/m)	0.13	1.0	water retention
	Surface Hardness (psi)	114	10.0	
	Subsurface Hardness (psi)	304	1.0	Subsurface Pan/Deep Compaction
BIOLOGICAL	Organic Matter (%)	2.5	2.0	energy storage, C sequestration, water retention
	Active Carbon (ppm)	566	2.0	soil biological activity
	Potentially Mineralizable Nitrogen (µgN/ gdwsoil/week)	5.1	3.0	
	Root Health Rating (1-9)	2.9	8.0	
CHEMICAL	pH (see CNAL Report)	7.3	10.0	
	Extractable Phosphorus (see CNAL Report)	11.0	10.0	
	Extractable Potassium (see CNAL Report)	51	7.5	
	Minor Elements (see CNAL Report)		10.0	
OVERALL QUALITY SCORE (OUT OF 100)			LOW	54.6

PERCENTILE RATING*

Ratings on this report are based on generalized crop production standards for New York. For crop specific nutrient interpretation and recommendation, see the attached chemical test report.

Figure 1. A typical Cornell Soil Health Test Report.

The Report (Figure 1) has been optimized towards improved soil management practices. For each, color-coded results shown on the report include the measured value, a 1-10 rating (<3 red, 3 - < 8 yellow and > 8 green) scaled according to soil texture, a listing of constraints when a rating is less than 3 (low), and a percentile rating that relates the measured values to others in our database. An overall soil quality score at the bottom integrates the suite of indicators. It is important to recognize that the information presented in the report is not intended as a measure of a grower's management skills. Instead, the report is really a tool that allows growers to target their management efforts to address specific soil constraints. Complex soil interactions prohibit extensive judgments of results between the soil indicators except in the case of controlled studies where adequate randomization and sampling intensity can allow for such hypothesis testing.

Soil Health Data Scoring

The CSHT Report shown in Figure 1 is from an intensively managed silt loam soil. Low values of three physical and two biological indicators return red ratings and the soil functional constraints are listed. This soil would be susceptible to crusting and hard-setting with low water storage capacity. A deep restrictive layer or 'pan' is present. The low amount of organic matter is coupled with low activity of soil organisms.

As an entry point in our understanding of soil health, we can take any identified soil constraint as management targets. When multiple constraints are considered together we can develop a best management plan to restore full functionality to the soil. Efficient users of the information will realize that implementing a single practice can affect more than one indicator and therefore multiple soil functional properties.

Figure 2 is taken from the Cornell Soil Health Assessment Training Manual (Gugino et al. 2007), which provides more extensive information on the CSHT and management practices. The Cornell Soil Health Training Manual can be downloaded at soilhealth.cals.cornell.edu. Figure 2 shows linkages between measured soil constraints and soil management practices for both the short- and long-term. Combining these with growers' needs and abilities provides for active scenario-testing and discussion. This facilitates

Linking Soil Health Indicators to Management

LOW AGGREGATE STABILITY:
short-term: integrate shallow-rooted cover or sod-rotation crops, add manures
long-term: reduce tillage intensity
LOW AVAILABLE WATER CAPACITY:
short-term: add stable organic matter (e.g. compost)
long-term: reduce tillage intensity
HIGH SURFACE HARDNESS:
short-term: localized physical soil loosening (e.g., strip tillage); frost tillage, cover crops and organic matter additions
long-term: integrate shallow-rooted cover or rotation crops; avoid traffic on wet soils; use controlled traffic lanes
HIGH SUB-SURFACE HARDNESS:
short-term: targeted physical soil loosening at depth (e.g., zone building, ripping, strip tillage); integrate deep-rooted cover crops
long-term: avoid moldboard plows and disks that generate tillage pans; reduce equipment loads; avoid heavy equipment traffic on wet soils
LOW ORGANIC MATTER and LOW ACTIVE CARBON:
short-term: integrate cover or sod rotation crops; add manure or compost
long-term: reduce tillage
LOW POTENTIALLY MINERALIZABLE NITROGEN:
short-term: add N-rich organic matter (not excessive); use legume cover / rotation crops
long-term: reduce tillage
HIGH ROOT ROT RATING:
use proper rotations, cover crops, appropriate chemical and biological control products
LIMITING LEVELS OF pH OR NUTRIENTS: see CNAL recommendations

Figure 2. Long- and short-term management strategies to address soil health indicator constraints.

knowledge sharing between regional extension educators, consultants, and growers. Local 'success stories' of specific management practices that effectively address targeted soil constraints also provide for a regional knowledge base of soil management consequences. There are no specific 'prescriptions' for what management regimen must be followed to address the highlighted soil health constraint, yet we can recommend a number of effective practices to address specific constraints.

The Soil Health Management Toolbox (Figure 3) lists the main categories of action for soil management. These techniques can be used singly or in combination. The same constraint can be overcome through a variety of management options. The option a grower chooses may depend on farm-specific conditions such as soil type, cropping, equipment and labor availability etc. Therefore, each grower is faced with a unique situation in the choice of management options to address soil health constraints. Different land use systems afford their own sets of opportunities or limitations to soil management.

The Soil Health Management Toolbox

⇒ Reducing or modifying Tillage
⇒ Crop Rotation
⇒ Growing cover crops
⇒ Adding organic amendments

Figure 3. Strategies for soil health management.

The principles outlined below can assist in interpreting the Cornell Soil Health Test Reports.

1. The report is a management guide and not a prescription: The report basically shows the aspects of the soil needing attention in order to enhance productivity and sustainability. Growers should see this report as a tool in planning the best soil management strategies for their fields. The new information provided by the test on the physical and biological aspects of the soil, together with the nutrient analysis results gives a better picture on the state of soil health.

2. Different management approaches can be used to mitigate the same problem: As previously mentioned, the choice and details of management efforts to be used in overcoming soil health constrains are dependent on resources available to the farmer. For example, growers seeking to increase the soil organic matter of their fields might approach this either by using reduced tillage practices or by adding organic manure or by combining both methods, the latter generally yielding the best results.

Grain Crop Grower Issues

Fields managed for top grain crop production are well suited to reduced tillage/ planting systems. No-till drilling of grain crops reduces soil disturbance and saves operator time. Heavy harvesting equipment in the field can compact surface and subsurface soil layers. Choosing shorter-season crop varieties may open planting windows for short season cover crop (green manure) establishment. Identify windows for application of off-farm sources of manure and composts.

3. In addressing some soil constraints, management practices can affect multiple indicators: Many of the soil health indicator measurements can benefit from a single management practice. For example, adding manure to the soil improves soil aggregation; increases organic matter and active carbon content; and improves soil nutrient status. However, the magnitudes of these effects are dependent on the specific management practices and soil types.

4. While certain indicators are generally related, a direct explanation of indicator relationships may lead to misleading interpretations: While the soil health indicators are generally inter-related, the degrees of interrelationships vary with soil type and previous management history. For example, a general linear relationship exists between organic matter and active carbon contents in many of our samples. However, there are some cases where this relationship is not true. Active carbon deals with relatively fresh organic carbon available for easy microbial decomposition. A soil may be high in organic matter but be lacking the fresh decomposable component, which leads to a low active carbon content.

5. Direct comparison of two fields that have been managed differently may lead to confounded interpretations: Comparing two test reports of fields from different areas or that have been managed differently are not valid ways to use the CSHT report. The absence of baseline data from such comparisons makes it impossible to judge the direction of change of the soil health indicators. However, if a field was managed the same way and then divided up into sections with different management practices, the CSHT can be used to compare these management alternatives.

Choose Management Approach from Information and Ability

When soil constraints are identified, it is important to implement soil management strategies that specifically address the issue(s) without negatively affecting the soil.

Choice of the most appropriate techniques will vary with grower expertise. If multiple constraints are identified, adoption of efficient or innovative management practices can address target issues simultaneously.

6. Soil health changes slowly over time: Generally, management recommendations to address soil health constraints take time for desired effects to be shown. This is unlike what happens with chemical amendments such as fertilizers. Some changes can be seen in the short term while other management options take a longer period to effect change. For example, deep tillage to address subsurface compaction can produce an immediate effect within a season. However, planting of deep rooted cover crops or conversion to no-tillage may take up to 3-5 years before changes can become noticeable. Remember, soil health management is a long-term strategy!

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2008

Alternative Strategies to Increase Cover Cropping in Vermont

Prepared by Heather Darby, heather.darby@uvm.edu and Roger Rainville, rcra@fairpoint.net

Project Summary:
Over a two year period, The Farmer's Watershed Alliance (FWA) increased the acres of effective cover crops in the St. Albans and Missisquoi watersheds. The acreage of cover crop increased from approximately 100 acres in 2006 to more than 1500 acres in 2008. This increase in cover cropping was largely due to the demonstrations, workshops, and other local partnerships implement by the FWA.

Project Objectives:
The FWA will increase farmer awareness and adoption of a best management practice by demonstrating innovative cover crop/reduced tillage cropping systems. The following demonstration projects were initiated on-farms to meet the objective.

1. Investigate cover crops interseeded into corn before harvest.

In 2007, cover crops were interseeded into the corn crop before harvest. The cover crop seeded was winter rye with hairy vetch, red clover, white clover, or sweet clover. The interseeding was compared to other seeding methods on a farm in Highgate. The rye (100 lbs/acre) and legume (15 lbs/acre) mixes were seeded at time of nitrogen topdress and/or at last cultivation (early to mid-July). In the spring, the cover crop was measured to determine the percentage of ground cover (Table 1).

Table 1. Impact of cover crop seeding method and date on average (n=2) soil cover (%).

Practice	Planting Date	Soil Cover
		%
Interseed	28-Jul	58
Drilled	27-Sep	78
Drilled	12-Oct	58
No cover crop		8

The cover crop appeared to be spotty where the tractors were driven during corn harvest. Overall, in the spring the legumes were barely visible and we felt that the small amount of potential nitrogen would not justify the added cost of legume seed. The legume seed cost approximately $45 per acre. This would potentially raise the cost of seed for cover cropping from $35 to $80 per acre. In addition, the best soil coverage was found when winter rye was seeded in late September.

2. Investigate manure incorporation in corn fields with Aerway System.

Two farmers conducted a few simple comparison studies to evaluate this system. The treatments included manure broadcast & chisel plow immediately, manure broadcast & Aerway immediately, manure broadcast & & chisel plow 5 days later. We evaluated nitrogen retention (pre-sidedress nitrate tests) and corn yields. We found that using an Aerway to incorporate manure provided similar results compared to chisel plowing immediately (Table 2).

Table 2. Impact of manure incorporation methods on corn silage yields.

	Nitrogen need	Yield
	lbs/acre	tons/acre
Chisel, immediate	71	20.3
Aerway, immediate	73	21.4
Chisel, 5 days later	85	19.8

3. Investigate cover crop seeding methods on corn silage fields.

Aerwav: Swanton. VT

In October of 2007, members of the Farmer's Watershed Alliance in the Missisquoi and St. Albans Bay Watersheds initiated on-farm demonstration projects. 5 farms implemented 4 different treatments outlining various ways to apply winter rye and manure. The treatments were:

1) surface manure, no tillage, no seed
2) surface manure, conventional tillage, winter rye
3) winter rye, aerway reduced tillage, no manure
4) winter rye, manure, aerway reduced tillage

Cover crop biomass and soil coverage were evaluated on demonstration farms. The amount of soil coverage was highly dependent on the planting date. The best cover crop stands were seeded from mid-September to early October. Some of the late October planting dates did not survive the winter. Of the 5 farms that hosted demonstrations, 2 planted the cover crop at the end of October. These demonstrations did not produce sufficient growth to provide cover and died from winter kill. In the remaining on-farm demonstrations, farmers found sufficient growth and coverage from various methods of incorporation (Table 3). Some of the best stands of cover crops were achieved from fall chisel plowing or Aerway and broadcast seeding. Soil quality (active carbon, potentially mineralizable nitrogen and aggregate stability) was measured on the 3 cover cropped fields and non cover cropped fields. Cover cropping improved soil quality when compared to continuous corn silage fields (Table 4). The project also highlighted the potential for cover crops to conserve fall applied manure nitrogen. It was calculated that the cover crop biomass had approximately 200 lbs of nitrogen that could be made available to the corn crop (Table 3). We hope to explore this benefit of cover cropping in future research with UVM Extension.

Table 3. Cover crop data collected from on-farm demonstration trials.

Treatment	Dry matter tons/acre	Nitrogen %	Nitrogen lbs/acre	Soil Cover %
Plow & Seed	0.66	3.22	43	54
Groom & Seed	0.90	3.23	59	94
Groom & Seed & Aerway	1.10	3.22	71	35
Seed & Aerway	1.44	3.34	96	98
Groom & Aerway & Seed	2.50	4.00	200	95
Aerway & Seed	2.50	4.00	200	97
Chisel & Seed	2.50	4.00	200	97
No Cover Crop	0.00	0.00	0	3

Table 4. Average impact of cover cropping on soil quality (n=3).

	Yield 65% moist.	**Water stable aggregates**	**Organic matter**	**Active carbon**	**Potentially Mineralizable N**
	Tons/acre	%	%	mg kg^{-1}	ug N g^{-1} d soil
Continuous corn silage	25	58.9	3.65	705	14.8
Continuous corn silage w/ cover crop	27	61.9	3.78	703	17.0

4. Investigate manure application techniques on hay fields.

An on-farm trial was conducted to evaluate various manure spreading techniques including broadcast, injection, and aerway implements. Some preliminary data is reported in table 5.

Table 5. Manure incorporation data on hayfields from Highgate, VT.

	Yield	**CP**	**ADF**	**NDF**	**TDN**	**NeL**	**IVTD**	**dNDF**
	t/acre	**%**	**%**	**%**	**%**	**%**	**%**	**%**
Injection	3.69	18.0	33.1	55.7	61.5	0.6	71.5	50.5
Aerway	4.57	17.8	36.2	57.2	64.5	0.6	75.0	56.0
Broadcast	3.54	16.0	36.7	58.0	64.5	0.6	74.5	56.0
No manure	2.03	15.5	34.2	55.9	65.0	0.6	76.0	57.0

Since there was a considerable amount of rainfall during the time period there were few differences among treatments. However, the farmer commented that injection cost twice as much compared to broadcasting. The Aerway was less expensive and more adaptable to various soil types (i.e. rocky fields).

5. Economic and Environmental Benefits to Farmers and Vermont.
Through this project we have documented farmer practices and associated costs. We have also tried to assign a value to a few of the cover cropping benefits. Every farm is unique and therefore we tried to use average values based on common cover crop practices. The average cost of cover crop seeding is $53 per acre. This includes a seed cost of $0.34, $5 per acre for seeding, and incorporation cost of $11 per acre. We documented that cover cropping could cost as little as $37 and as much as $100 per acre depending on practices. Many farmers also documented increased costs due to additional tillage needed to incorporate the cover crop in the spring. It is difficult to put a price on environmental benefits such as reduced erosion and improved soil quality. However, these benefits are sometimes indirectly related to crop yields. Some of the farmers in the project did document increased yields as a result of cover cropping. On average farmers reported a 2 ton increase per acre in corn silage yields. At the current price of corn silage that has a value of $100 per acre. In addition, we documented a potential improvement in nitrogen conservation. Although this topic needs further investigation we would very conservatively allow a 50 lb N per acre credit for a cover crop seeded in late September. At the current price of N we would project a $30 per acre saving in nitrogen costs. It is obvious from the project that cover cropping had the potential to conserve up to 200 lbs of N per acre with cost savings of $120 per acre. In addition, some farmers documented less fuel use when tilling in cover crops in the spring. They were able to plow in a higher gear than normal. Farmers predicted that this could be a $4 per acre fuel savings. It is definitely possible for cover crops to be of major economic benefit to the farmer. However, it is obvious from this project that proper cover cropping practices must be implemented to reap these benefits to the maximum potential.

Cost of Cover Cropping: $37 - $100 per acre

Seed: $34 - $70 (includes legumes)
Seeding costs: $3-$10
Seed incorporation costs: $10 - $15
Additional incorporation costs in spring: $10 - $20

Benefit of Cover Cropping: $0 - $234 per acre

Yields: 2 tons of feed per acre = $0 to $100
Fuel Savings = -$14 to $4 per acre
Nitrogen Fertilizer Savings = $0 to $120

FORAGE CONFERENCE
MIDDLEBURY, VT
March 10, 2009

Russ Hahn
Crop and Soil Sciences
Cornell University

FORAGE CONFERENCE

- Effectiveness of PRE and POST weed control programs for corn
- Annual grass burndown in corn
- Herbicide resistant weeds
- Halex GT for RR or GR corn
- Lambsquarters control in GR corn
- New safened DuPont products

FORAGE CONFERENCE

- Effectiveness of PRE and POST weed control programs for corn

PRE PROGRAMS

ADVANTAGE - Control is up front and easy.

DISADVANTAGE - Depends on rainfall for activation. From 0.5 – 1 inch within 7 to 10 days.

PRE PROGRAMS

Bicep Lite II Mag	-	Dual II Mag + Atrazine
Cinch ATZ Lite	-	Cinch + Atrazine
Bullet	-	Mico-Tech + Atrazine
G-Max Lite	-	Outlook + Atrazine
Lumax	-	Dual II Magnum + Atrazine + Callisto
Harness Xtra	-	Harness + Atrazine
Prowl H2O	+	Atrazine

TOTAL POST PROGRAMS

ADVANTAGE - Allows scouting to identify weeds and choose herbicides

DISADVANTAGE - Timing is critical, must be done before crop losses.

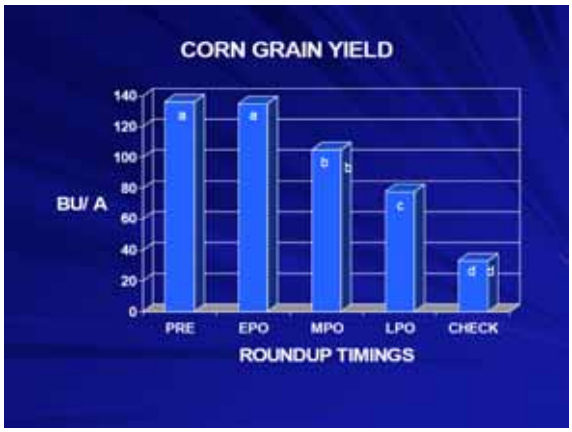
TIMING OF ROUNDUP AFFECTS CORN YIELD

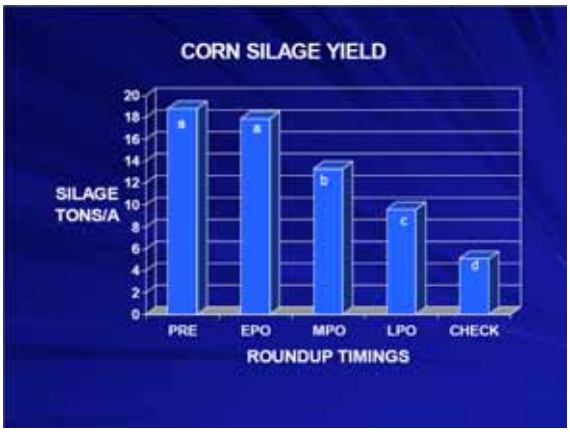
Location - Aurora Farm
2002, 2003, and 2004

Hybrids - DKC42-70RR, 92-day
DKC53-33RR, 103-day

AVERAGE WEED HEIGHT

Time	RAG	LAMB	FOX	MUST
EPO	2-3"	1-3"	1-4"	2-4"
MPO	3-6"	3-8"	4-6"	9-14"
LPO	8-12"	4-10"	6-14"	12-24"





TOTAL POST TIMING

- Roundup Ready hybrids target 2- 4 inch weeds.
- Conventional hybrids target 1-2 inch weeds.

FORAGE CONFERENCE

- Effectiveness of PRE and POST weed control programs for corn
- Annual grass burndown in corn

ANNUAL GRASS BURNDOWN PRODUCTS

Product Names	Group Site of Action	Chemical Company
Impact	Group 27	AMVAC
Callisto	Group 27	Syngenta
Steadfast	Group 2	DuPont

HOW DO BURNDOWN PRODUCTS FIT?

- Have value for burndown when "PRE" herbicides are applied EPOST or MPOST
- Have potential for use in planned total POST programs

POST GIANT FOXTAIL

ACOR1007 & VCOR1807

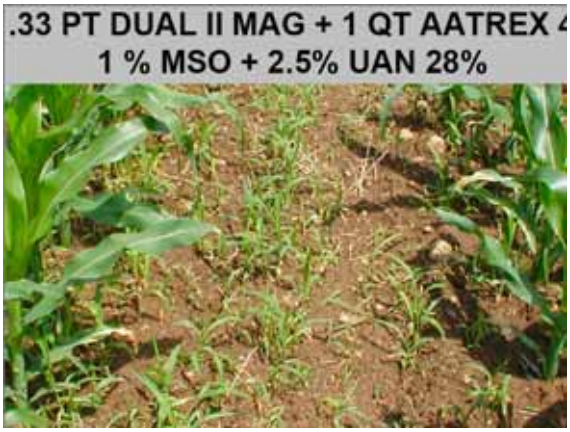
	Aurora	Valatie
Hybrid	Pioneer 38P05	Pioneer 38P05
Planted	May 24,2007	May 17, 2007
Sprayed	EPO – June 13	MPO – June 10
Giant Foxtail	2.5 inches	4 inches

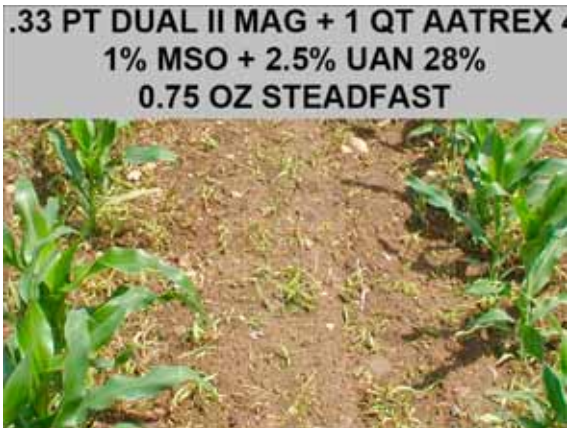
POST GIANT FOXTAIL

ACOR1007 & VCOR1807

Herbicides*	Rate Amt/A	Control (%) ~3 WAT	12 WAT
Residual	Full Rate	41	19
+ Impact	0.75 fl oz	95	95
+ Steadfast	0.75 oz	95	93
LSD (0.05)	-	6	6

*With 1% (v/v) MSO and 2.5% (v/v) 28% UAN.





POST GIANT FOXTAIL

ACOR1007 & VCOR1807

Herbicides*	Rate Amt/A	Yield (Bu/A)
Residual	Full Rate	105
+ Impact	0.75 fl oz	142
+ Steadfast	0.75 oz	137
Untreated	-	53
LSD (0.05)		14

*With 1% (v/v) MSO and 2.5% (v/v) 28% UAN.

EPO LARGE CRABGRASS

ACOR1507

- Pioneer 38K46 - May 4, 2007
- EPO treatments - May 22
  crabgrass ~ 0.5 inch
- Rainfall 0.47" in 1st week
  0.24" in 2nd week

EPO LARGE CRABGRASS

VCOR1507

Herbicides*	Rate Amt/A	Control (%) 3 WAT	6 WAT
Residual	Full Rate	73	58
+ Callisto	3 fl oz	99	98
+ Impact	0.75 fl oz	97	95
+ Steadfast	0.75 oz	97	94
LSD (0.05)		6	6

*With 1% (v/v) COC and 2.5% (v/v) 28% UAN.

EPO LARGE CRABGRASS

VCOR1507

Herbicides*	Rate Amt/A	Yield Bu/A
Residual	Full Rate	120
+ Callisto	3 fl oz	149
+ Impact	0.75 fl oz	145
+ Steadfast	0.75 oz	139
Untreated	-	49
LSD (0.05)	-	14

*With 1% (v/v) COC and 2.5% (v/v) 28% UAN.

2007 RESULTS

- Results showed value of burndown when applying "PRE" herbicides EPO or MPO
- 32 Bu/A advantage with foxtail
- 23 Bu/A advantage with crabgrass

POST GIANT FOXTAIL
ACOR1008

	Aurora
Hybrid	DKC 38-46
Planted	May 21,2008
Sprayed	EPO – June 19
Giant Foxtail	6 inches

EPOST GIANT FOXTAIL REDUCED RESIDUALS

Herbicides*	Rate Amt/A	% Control 6 WAT	Yield Bu/A
Residual	Full Rate	-	-
+ Impact	0.73 fl oz	100	Ave.
+ Steadfast	0.75 oz	100	206
Residual	Half Rate	-	-
+ Impact	0.73 fl oz	98	Ave.
+ Steadfast	0.75 oz	99	219
LSD (0.05)		10	31

*Applied with 1% MSO + 2.5% 28% UAN.

POST LARGE CRABGRASS
VCOR1608

	Valatie
Hybrid	Pioneer 38K46
Planted	April 25, 2008
Sprayed	EPO – May 28
Large Crabgrass	1.25 inches

EPOST LARGE CRAB - REDUCED RESIDUALS

Herbicides*	Rate Amt/A	% Control 6 WAT	Yield Bu/A
Residual	Full Rate	-	-
+ Impact	0.73 fl oz	95	Ave.
+ Callisto	3 fl oz	99	143
+ Steadfast	0.75 oz	83	
Residual	Half Rate	-	-
+ Impact	0.73 fl oz	86	Ave.
+ Callisto	3 fl oz	96	141
+ Steadfast	0.75 oz	83	
LSD (0.05)		15	14

*Applied with 1% MSO + 2.5% 28% UAN.

ANNUAL GRASS BURNDOWN

- Now recommend half rates of residual herbicides with Impact or Steadfast for burndown
- Impact or Steadfast would be the best choice for foxtails
- Callisto or Impact would be the best choice for large crabgrass

FORAGE CONFERENCE

- Effectiveness of PRE and POST weed control programs for corn
- Annual grass burndown in corn
- Herbicide resistant weeds

HERBICIDE RESISTANT WEEDS SUMMARY 3/09

Herbicide Group	WSSA Group	Example Herbicide	Total
ALS inhibitor	2	Steadfast	97
Triazine	5	Atrazine	67
ACCase inhibitor	1	Fusilade	35
Synthetic Auxin	4	2,4-D	27
Bipyridilium	22	Gramoxone	24
Ureas and Amide	7	Lorox	21
Dinitroaniline, others	3	Prowl	10
Glycine	9	Roundup	15

HERBICIDE RESISTANT WEEDS SUMMARY 3/09

Herbicide Group	WSSA Group	Example Herbicide	Total
Thiocarbamates	8	Eptam	8
Triazoles, Ureas	11	Amitrole	4
PPO Inhibitors	14	Reflex	3
Chloroacetamides,	15	Dual II Mag.	3
Carotenoid Inhibitors	12	Zorial	2
Nitriles and others	6	Buctril	1
Others	-	-	6
Total Herbicide Resistant Biotypes			323

RESISTANCE MANAGEMENT

- Rotate crops
- Cultivate to control weeds that escape
- Use herbicides with little soil activity and/or short residual
- Rotate herbicide sites of action with continuous cropping
- Use tank mixtures or sequential treatments of herbicides with different sites of action

FORAGE CONFERENCE

- Effectiveness of PRE and POST weed control programs for corn
- Annual grass burndown in corn
- Herbicide resistant weeds
- Halex GT for RR or GR corn

HALEX GT

Active Ingredients	Active/ Gallon	Mode of Action
Dual II Mag	2.09 lb	GROUP 15 – inhibit long-chain fatty acids
Touchdown	2.09 lb	GROUP 9 – inhibit amino acid synthesis
Callisto	0.209 lb	GROUP 27 – inhibit pigment formation

HALEX GT FOR GR CORN

- 3.6 – 4 pt/A Halex GT with
  - NIS and AMS
  - EPOST - weeds 2 – 4 inches

HALEX GT CORN
ACOR0507 and ACOR0308

Herbicides	Rate Amt/A	% Control Rag	Lambs	Fox
Halex GT	3.6-4 pt	94	100	100
Halex GT + AAtrex 4L	3.6-4 pt 1 pt	98	100	99
Roundup	22 fl oz	85	56	75

HALEX GT CORN
ACOR0507 and ACOR0308

Herbicides	Rate Amt/A	Yield Bu/A
Halex GT	3.6 – 4 pt	183
Halex GT + AAtrex 4L	3.6 – 4 pt 1 pt	187
Roundup	22 fl oz	185

FORAGE CONFERENCE

- Effectiveness of PRE and POST weed control programs for corn
- Annual grass burndown in corn
- Herbicide resistant weeds
- Halex GT for RR or GR corn
- Lambsquarters control in GR corn

LAMBSQUARTERS GR CORN

CCOR1208

- 1 qt AAtrex 4L – April 24, 2008
- Pioneer 38M60 – planted April 24
- Mid-POST applications – June 21
  Lambsquarters – 7 inches tall
- Evaluation – 6 WAT (Aug. 2)

LAMBSQUARTERS GR CORN

CCOR1208

Herbicides*	Rate Amt/A	% Control 6 WAT	Cost/A
Roundup PM	22 fl oz	83	$7.42
Roundup PM	33 fl oz	96	$11.13
Halex GT + Induce	3.6 pt 0.25%	100	$20.36
LSD (0.05)		6	

*Applied with 1.7 lb/A AMS.

LAMBSQUARTERS GR CORN

CCOR1208

Herbicides*	Rate Amt/A	% Control 6 WAT	Cost/A
Roundup PM	22 fl oz	83	$7.42
Roundup PM	33 fl oz	96	$11.13
Roundup PM + Clarity	22 fl oz 4 fl oz	98	$10.40
LSD (0.05)		6	

*Applied with 1.7 lb/A AMS ($0.58/A)

FORAGE CONFERENCE

- Effectiveness of PRE and POST weed control programs for corn
- Annual grass burndown in corn
- Herbicide resistant weeds
- Halex GT for RR or GR corn
- Lambsquarters control in GR corn
- New safened DuPont products

"NEW" DUPONT PRODUCTS YOU SHOULD KNOW ABOUT

Products	Active Ingredients
Resolve Q*	Resolve + Harmony
Require Q*	Resolve + Dicamba (Banvel)
Steadfast Q*	Resolve + Accent

* All include a safener – isoxadifen.

NEW FROM DUPONT

- Resolve Q – Resolve + Harmony + Safener
- Nonvolatile contact plus residual glyphosate tank-mix partner.

GR CORN COMBINATIONS

ACOR0708

- DKC 42-91 planted May 13, 2008
- EPO – June 10
  Weeds 1 – 3 inches
- MPO – June 17
  Weeds 4 – 6 inches

GR CORN COMBINATIONS
ACOR0708

Herbicides*	Rate Amt/A	When Appl.	% Control Rag	% Control Fox
Roundup WM	22 fl oz	EPO	80	67
Roundup WM	22 fl oz	EPO	75	99
+ Resolve Q	1.25 oz	EPO		
Roundup WM	22 fl oz	EPO	99	98
+ Resolve Q	1.25 oz	EPO		
+AAtrex Nine-O	8.9 oz	EPO		
LSD (0.05)			16	10

*Applied with 2 lb/A AMS.

GR CORN COMBINATIONS
ACOR0708

Herbicides*	Rate Amt/A	When Appl.	Yield Bu/A
Roundup WM	22 fl oz	EPO	228
Roundup WM	22 fl oz	EPO	245
+Resolve Q	1.25 oz	EPO	
Roundup WM	22 fl oz	EPO	241
+Resolve Q	1.25 oz	EPO	
+AAtrex Nine-O	8.9 oz	EPO	
Untreated	-	-	134
LSD (0.05)			18

*Applied with 2 lb/A AMS.

NEW FROM DUPONT

- Require Q – Resolve + Dicamba + Safener
- Tank-mix partner for glyphosate.
- Contact & systemic activity with residual control.
- Two modes of action.

GR CORN COMBINATIONS
VCOR1808

Herbicides	Rate Amt/A	When Appl.	% Control Rag	% Control Fox
Roundup PM*	22 fl oz	EPO	99	99
+ Require Q	4 oz	EPO	100	100
+ Require Q	4 oz	EPO	99	99
+ AAtrex Nine-O	8.9 oz	EPO		
Dual II Mag	1 pt	PRE	0	99
LSD (0.05)			1	14

*Applied with 2 % (w/w) AMS.

GR CORN COMBINATIONS
VCOR1808

Herbicides	Rate Amt/A	When Appl.	Yield Bu/A
Roundup PM*	22 fl oz	EPO	163
+ Require Q	4 oz	EPO	155
+ Require Q	4 oz	EPO	172
+ AAtrex Nine-O	8.9 oz	EPO	
Dual II Mag	1 pt	PRE	110
LSD (0.05)			34

*Applied with 2 % (w/w) AMS.

CULTIVATING HEALTHY COMMUNITIES

Jeff Carter

UVM Extension Specialist
Field Crops & Nutrient Management

Middlebury, VT

March 10, 2009

UNIVERSITY OF VERMONT EXTENSION
CULTIVATING HEALTHY COMMUNITIES

Issue – Risk Management

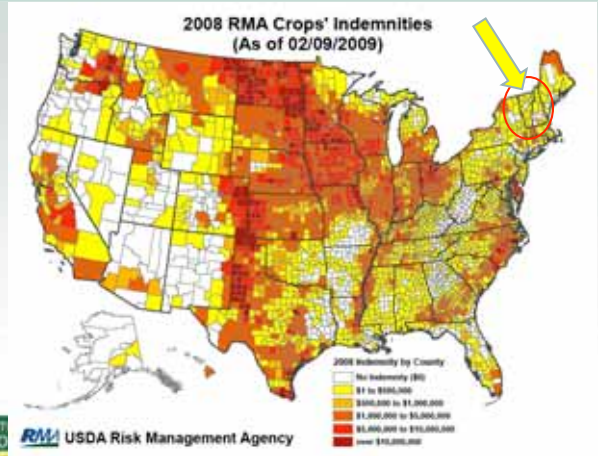
Try to Prevent
Bad Luck
BEFORE it Happens

UNIVERSITY OF VERMONT EXTENSION

CROPS

UNIVERSITY OF VERMONT EXTENSION

Crop Insurance Payments



Insurance - Dates to Remember

- Corn – March 16
- AGR Lite – March 16
- AGR – January 31
- Forage Seeding – March 16
- Sweet Corn – March 16
- Spring Wheat and Barley – March 16

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Crop Insurance

CAT Coverage – Minimum Coverage @ 50% loss
Buy-Up Coverage – Increase Coverage
AGR-Lite – Income Loss
Administrative Fee -
- CAT $300 per crop /county
- BU $30 per crop /county

PAM SMITH
Risk Management Educator

Vermont Corn 2008 – 473 Policies

Premiums	$1,185,892
Subsidy	$ 778,401
Farmer Cost	$ 407,491
Indemnity Paid	$ 956,854
Net Gain to VT	$ 549,363

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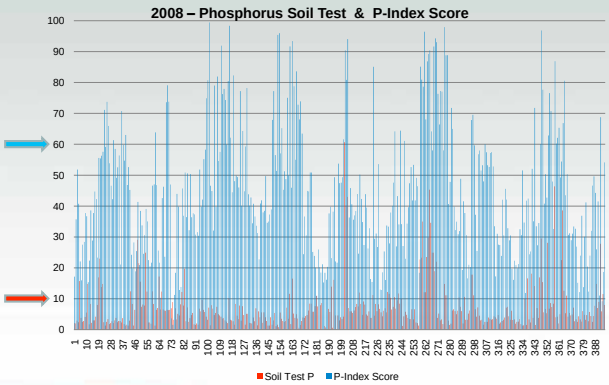
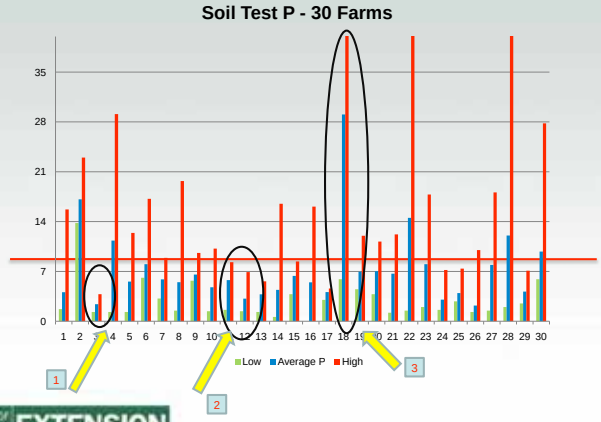
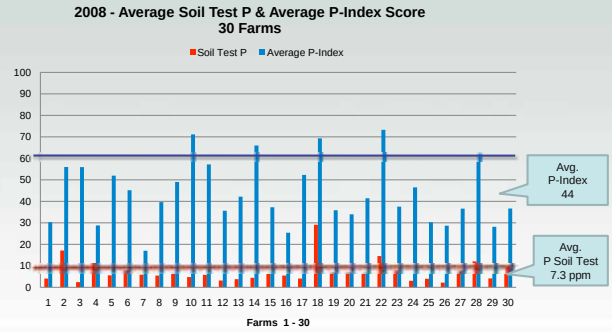
Look at Your Soil Test



Results for All Farms



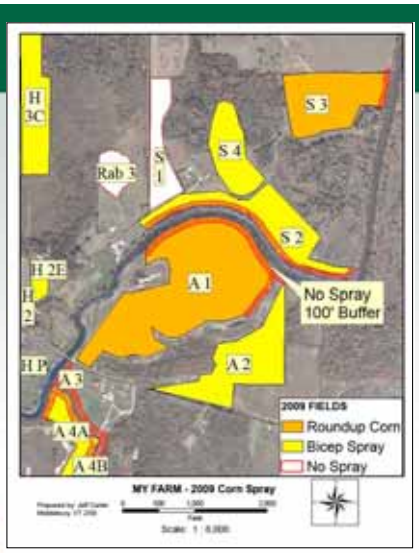
Results for All Farms



30 Farms	75% Hayland	Average P Index all Fields	44.0
395 Fields	25% Row Crop - CS,Soy	Highest P-Index	99.4
4,485 Acres		Lowest P-Index	1.6
		Average Soil Test P	7.3
		Highest Soil Test P	60.7

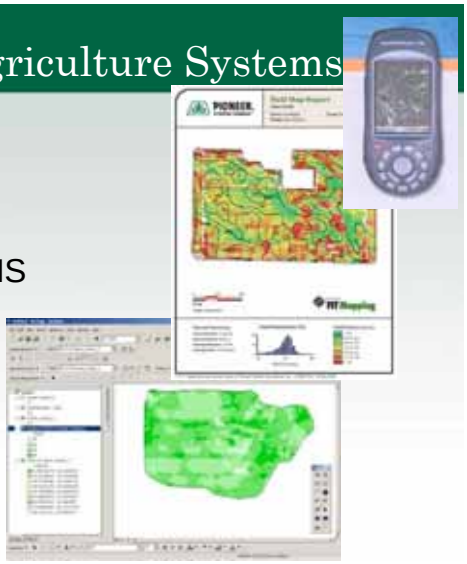
Field Application Maps

Avoid Confusion



Precision Agriculture Systems

- ArcGIS
- Pioneer FIT
- JD Office
- Ag Leader SMS
- Raven
- SST
- HGIS
- Farm Works



GPS Manure Application Map

Milk Price Risk Management

RMS Forward Contracts - Fence Contracts

Glenn Rogers – UVM Extension

FOR MORE INFORMATION

Jeff Carter

(802) 388-4969 1-(800)-956-1125

Email: JEFF.CARTER@UVM.EDU

Northern Corn Leaf Blight

Dr. Heather Darby, Agronomic Specialist, UVM Extension

Northern leaf blight (NLB) is a fungal disease found in humid climates wherever corn is grown. The disease thrives when relatively cool summer temperatures coincide with high humidity and available moisture. The number of NLB outbreaks has increased considerably over the past 5 years. Since this disease Corn silage yield and quality losses from this disease can be significant. Therefore it is important for us to gain a better understanding of the disease cycle, symptoms, and management practices that can be employed to reduce the impact of NLB on the corn crop.

Disease Cycle

Northern corn leaf blight is caused by the fungus *Exserohilum turcicu.* It overwinters as mycelia and conidia in diseased corn stalks (Figure 1). In the spring and early summer, spores are produced on this crop residue when environmental conditions are favorable. Primary infections occur when spores are spread by rain splash and air currents to the leaves of new crop plants. Infection will occur if free water is present on the leaf surface for 6 to 18 hours and temperatures are 65 to 80℉.

Secondary infections occur readily from plant to plant, and even from field to field. Infections generally begin on lower leaves first and then progress up the plant. Heavy dews, frequent light showers, high humidity, and moderate temperatures favor the spread of the disease.

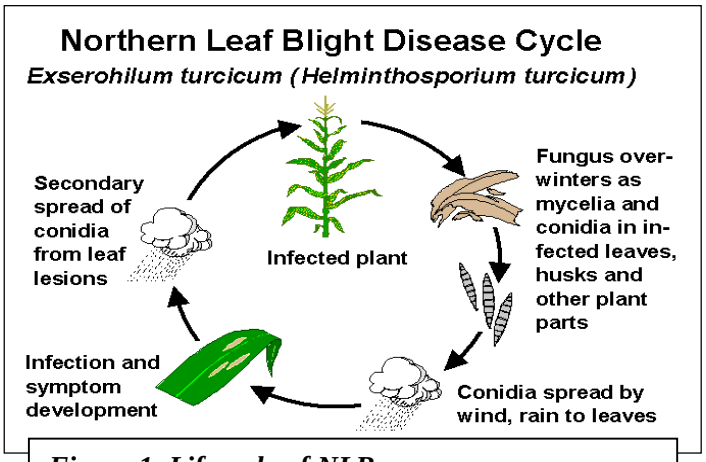


Figure 1. Lifecycle of NLB.

Disease Symptoms

Within 2 weeks of infection grey elliptical lesions begin to develop on the leaves. Over time the cigar shaped lesions become tan as they enlarge (Figure 2). Under moist conditions, the lesions produce dark gray spores on the lower leaf surface. As many lesions enlarge and coalesce, entire leaves or leaf areas may be covered.

Figure 2. Characteristic tan cigar shaped lesions of NLB (photo Univ. KY)

It is obvious that the more leaf area that becomes damaged from this disease the more yield and quality losses that maybe incurred. Generally, the damage on the plants is seen after silking, however, there have been earlier infections reported in the moist valley regions.

Disease Management

One of the most effective means of managing NLB is selecting resistant corn hybrids (Figure 3). Since we have not recognized this disease as a major threat focus on resistant hybrid selection has not been a priority. Hybrids with above average resistance to NLB should be planted. Work with your corn seed representative to select hybrids that meet these criteria.

Figure 3. NLB susceptible (left) and resistant (right) silage hybrid in Vermont.

Since corn residues harbor the disease, all fields that are grown for grain may be at the greatest risk for disease infection. In areas where NLB problems have occurred in recent years, reducing any previous corn residue is important to minimize disease inoculum and its effects. Corn residue can be reduced through several practices including crop rotation and moldboard plowing. Remember that this disease has been seen primarily in continuous corn silage fields in Vermont. Therefore any amount of residue will build increase the risk of this disease.

Although there are fungicides available to protect the corn from this disease they are generally not considered cost effective in corn silage systems.

If you suspect that your corn has Northern Corn Leaf Blight please report the incidence to UVM Extension Agronomists Heather Darby & Sid Bosworth. For more information please contact Heather Darby at (802) 524-6501 or heather.darby@uvm.edu.

Vermont Corn Rootworm Project

2000: Less than 15% of the fields monitored were above threshold (40 fields in two counties)

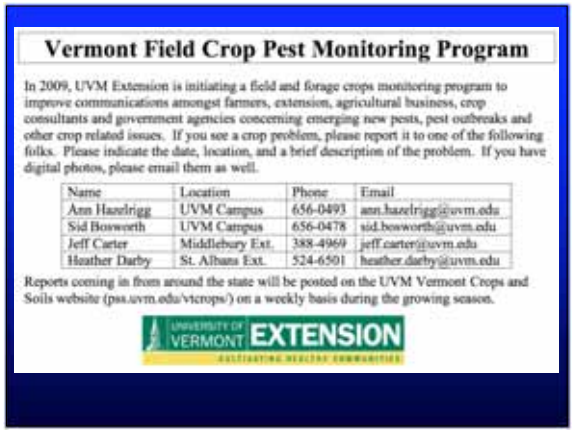
2001: Three to five fields (out of 27) were above threshold (five counties)

2003: Only 3 out of 23 fields (13% of the total) were clearly above the critical threshold (Addison County)

Generally, less than 20% of total corn rootworms were Western.

Vermont Corn Rootworm Project

2008: So far, 13 out of 35 (37%) fields we monitored were found to be above threshold in Addison, Chittenden, Franklin and Orange Counties



Vermont Field Crop Pest Monitoring Program

In 2009, UVM Extension is initiating a field and forage crops monitoring program to improve communications amongst farmers, extension, agricultural business, crop consultants and government agencies concerning emerging new pests, pest outbreaks and other crop related issues. If you see a crop problem, please report it to one of the following folks. Please indicate the date, location, and a brief description of the problem. If you have digital photos, please email them as well.

Name	Location	Phone	Email
Ann Hazelrigg	UVM Campus	656-0493	ann.hazelrigg@uvm.edu
Sid Bosworth	UVM Campus	656-0478	sid.bosworth@uvm.edu
Jeff Carter	Middlebury Ext.	388-4969	jeff.carter@uvm.edu
Heather Darby	St. Albans Ext.	524-6501	heather.darby@uvm.edu

Reports coming in from around the state will be posted on the UVM Vermont Crops and Soils website (pss.uvm.edu/vtcrops/) on a weekly basis during the growing season.

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