

Michael Copas, A.J. Bussan, and Michael Drilias
University of Wisconsin-Madison
Department of Horticulture

Nitrogen Mineralization and Uptake in Snap Bean and Sweet Corn

Cover Crops in Central Wisconsin

- Current system problems
 - Single focus on erosion, limited species
 - NO₃ contamination, cost of N fertilizer, lack of N crediting information
- Cover Crop Benefits
 - Erosion control
 - Accumulation of excess N / production of N
 - Rotational effect
 - Weed and pest control
 - Increased soil structure & organic matter
 - Biofumigant properties

Project Basis

- Current Crop Rotation
 - Snap bean - - Rye - - Sweet Corn - - Rye - - Potato - - Rye
- Rye not functional outside of erosion control
- Cover Crop Intensive Rotation
 - Continuous Cropping
 - Reduced Inputs
 - Disease Management
 - Improved SOM and quality

Annual Cover Crop System

- Field Pea, Oats, 50:50 Field Pea/Oat Mixture, No Cover Crop
- Spring planted cover crops
- Green manure before snap bean
- No yield response in snap bean
- Differences in N levels in plant and bean pods

Snap Bean Yield

Snap Bean Yield

Cover Crop Species	2007		2008	
	0 lbs. N / Acre	60 lbs. N / Acre	0 lbs. N / Acre	60 lbs. N / Acre
50:50 Mix	2.26	2.86	2.33	2.92
Field Pea	2.40	2.72	2.29	2.89
Oat	2.16	2.70	2.58	3.00
No Cover	2.01	2.78	2.48	3.15
	b	a	b	a

Snap Bean N Uptake

Snap Bean Nitrogen Use

Cover Crop Species	Agronomic Efficiency				Total Plant N Uptake			
	0 lbs. N		60 lbs. N		0 lbs. N		60 lbs. N	
	/ Acre		/ Acre		/ Acre		/ Acre	
					lbs. / A			
50:50 Mix	0.65	c	1.48	b	51.93	b	68.43	a
Oat	0.36	c	1.19	b	52.06	b	65.79	a
Pea	0.65	c	1.38	b	52.12	b	69.22	a
No Cover			1.75	a	44.03	c	65.25	a

Snap Bean Pod N

Snap Bean Pod Nitrogen

	N Content of Bean Pods				N Recovery			
	0 lbs.		60 lbs.		0 lbs.		60 lbs.	
Cover Crop	N / Acre		N / Acre		N / Acre		N / Acre	
Species	% N in Tissue				lbs. N / A			
50:50 Mix	3.47	b	3.73	a	16.11	b	20.36	a
Oat	3.48	b	3.71	a	16.40	b	20.36	a
Pea	3.56	ab	3.79	a	16.28	b	20.67	a
No Cover	3.31	c	3.55	ab	14.62	c	21.00	a

Snap Bean Yield Response

- Yield response to N fertilizer
- No yield response to cover crops
 - Syncing of N release vs. N demand
 - Luxury consumption by snap bean
- Snap Bean = Poor Model
 - Low N demand
 - Nutrients not critical to root rot
- Long Term Changes to Soil
 - Increase in SOM
 - Increased soil quality

Perennial Cover Crop System

- Red Clover, Alfalfa, Alsike Clover, Sweet Clover, Hairy Vetch, Rye/None
- Established under snap bean (Year 1)
- Persist under sweet corn (Year 2)
- Sweet corn with cover crops and 0 lbs. N applied produced 7.0 Tons/A yields in 2005

Sweet Corn Yield Results

2006 Sweet Corn

<u>N Rate</u>	<u>Yield</u>			
	<u>0 N</u>		<u>150 N</u>	
	<u>(Tons / A)</u>			
No Cover	1.82	f	8.36	ab
Hairy Vetch	6.88	de	8.89	a
Alfalfa	6.46	e	8.09	abc
Red Clover	7.32	bcd	8.82	ab
Sweet Clover	8.09	abc	8.58	ab
Alsike Clover	7.15	cde	7.86	b

Nutrient Use Efficiency

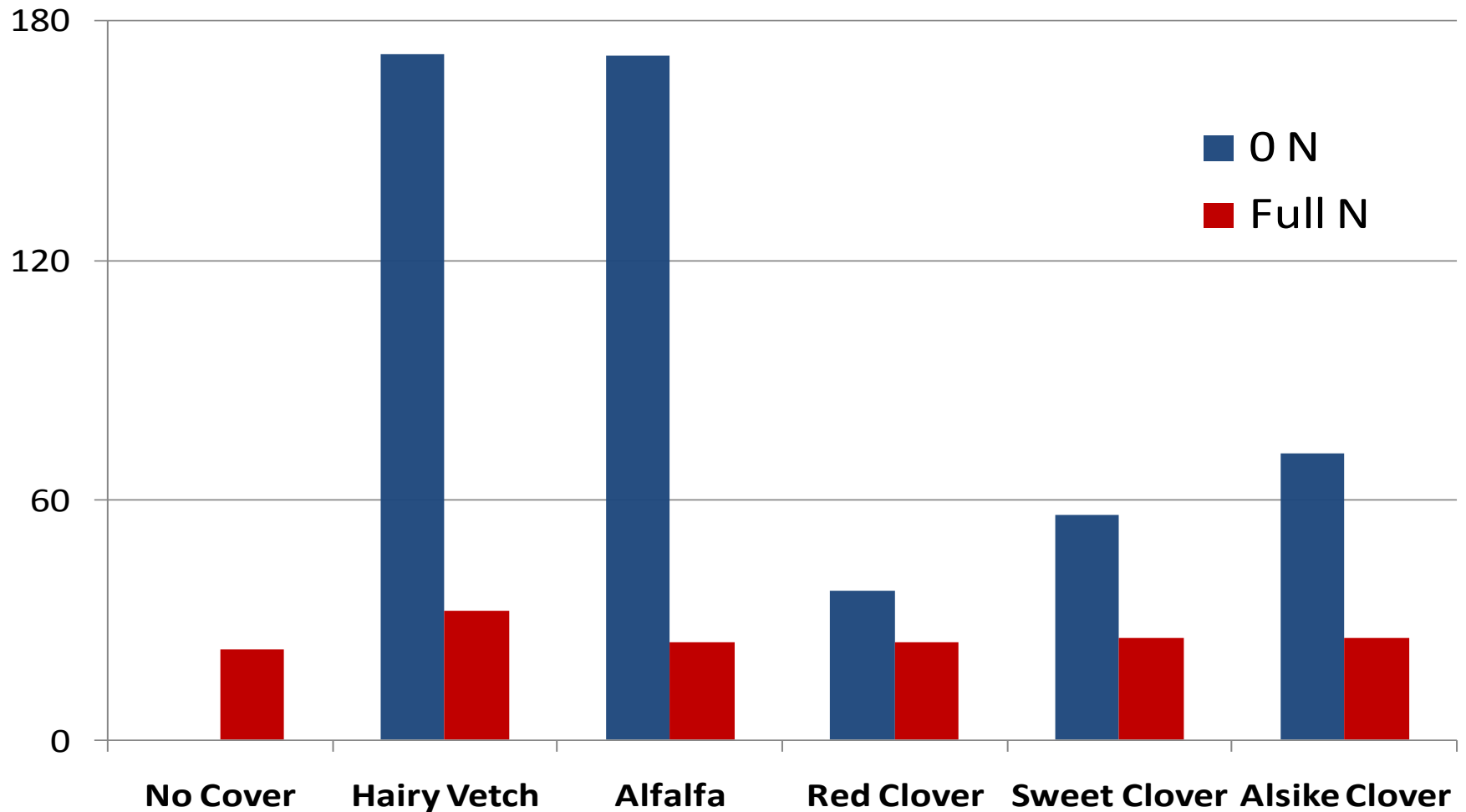
- Efficiency of uptake
- Conversion of N to yield
- Conversion of N to biomass production
- Importance to vegetable crops:
 - Productivity
 - Efficiency of fertilizer applied
 - Plant health and vigor
 - N provided by cover crops

Calculating Nutrient Use Efficiency

- Agronomic efficiency
 - $AE = (\text{Yield}_{\text{Full}} - \text{Yield}_{\text{Zero}}) / (\text{N Applied}_{\text{Full}} - \text{N Applied}_{\text{Zero}})$
 - Ability to convert fertilizer N into yield
 - Gain an approximation of fertilizer replacement

Perennial Cover Sweet Corn

2006 Sweet Corn Agronomic Efficiency



Sweet Corn Yield 2008

Year	Rate (lbs/A)	Clover Population							
		Low		Middle		High		No Clover	
		Yield (Tons / Acre)							
2008	0	2.67	g	2.60	g	4.54	f	2.93	g
	50	3.00	g	5.04	ef	4.28	f	4.57	f
	100	7.07	cd	8.13	bc	7.68	bc	6.07	de
	150	8.23	bc	8.82	ab	8.57	ab	6.61	cd
	200	9.31	ab	9.53	a	9.29	ab	6.63	cd

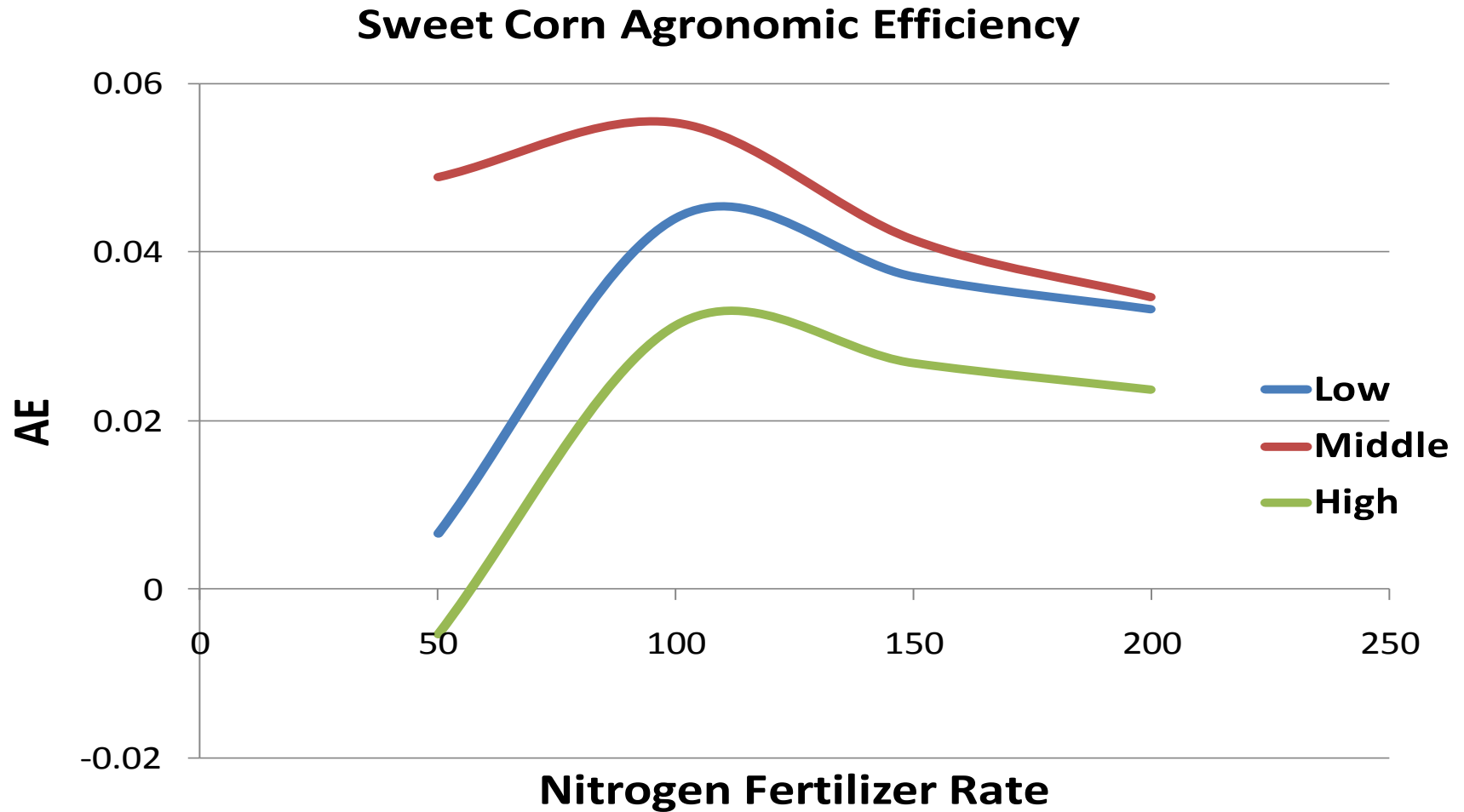
Low = 0 - 0.1 Ton/A, Medium = 0.1 - 0.4 Ton/A, High = > 0.4 Ton/A

Sweet Corn Yield 2009

Sweet Corn Yield

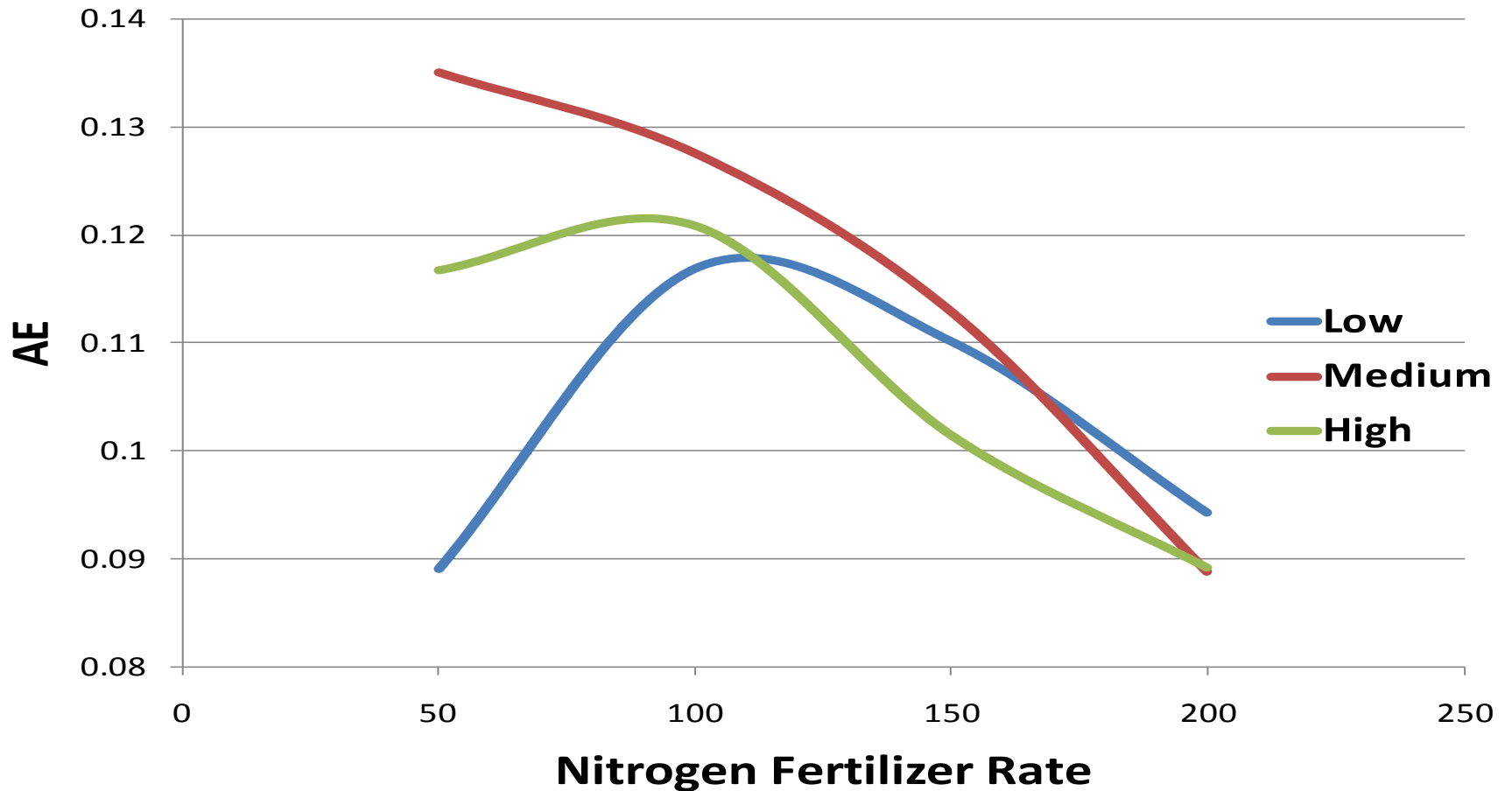
Year	Rate (lbs/A)	Clover Population							
		Low		Middle		High		No Clover	
		Yield (Tons / Acre)							
2009	0	1.95	k	2.14	jk	3.25	ij	1.58	k
	50	3.98	hi	5.20	gh	5.90	fg	4.57	h
	100	7.26	de	7.92	de	8.52	c	7.06	ef
	150	9.45	abc	9.82	a	10.62	a	8.48	bcd
	200	10.51	a	10.19	a	10.41	a	9.66	ab

2008 Sweet Corn



2009 Sweet Corn

Sweet Corn Agronomic Efficiency



Spring Clover Biomass

Spring Clover Biomass

Clover

Year	Planting Date	Biomass		Population	
		Tons / A		Plants / A	
2007	At Planting	1.32	a	100872	b
	Unifoliate	1.60	a	143473	b
	3rd Trifoliate	1.38	a	72961	c
	Bud Stage	1.08	a	118010	b
	Post-Harvest	1.30	a	341300	a

Conclusions

- Perennial cover crops have immediate benefits to vegetable system
- Improved N Use Efficiency
- Reduced Fertilizer N (50-66%)
- No response by snap bean in annual cover crop system
- Annuals may benefit in long rotations

Thank You To:

- Wisconsin Fertilizer Research Council
- Wisconsin Potato and Vegetable Growers Association
- Midwest Food Processors Association
- Hancock Agricultural Research Station
- Arlington Horticultural Research Station