

Trash or Treasure? Maximize the Value of Your Residue

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Department of Crop Sciences
University of Illinois Urbana-Champaign

2026 Field Advisor Webinar
Virtual, March 10th

Crop Physiology

Crop Physiology Laboratory Team – 2025

Professor and Research Professor
- Dr. Fred Below & Dr. Connor Sible

Principal Research Specialists
- Juliann Seebauer
- Jared Fender

Postdoctoral Research Associate
- Dr. Marli Favoretto

Ph.D. Student
- Sam Leskanich

Master's Students
- Gabriela Frigo Fernandes
- Ava Isaacs
- Derek Slifer
- Eric Morsink
- Wyatt Wessel

Visiting Research Scholars
- Renan Godoy de Marco
- Arthur Stasiak Jadoski
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- Lilian Gobel Kortstee

Crop Physiology

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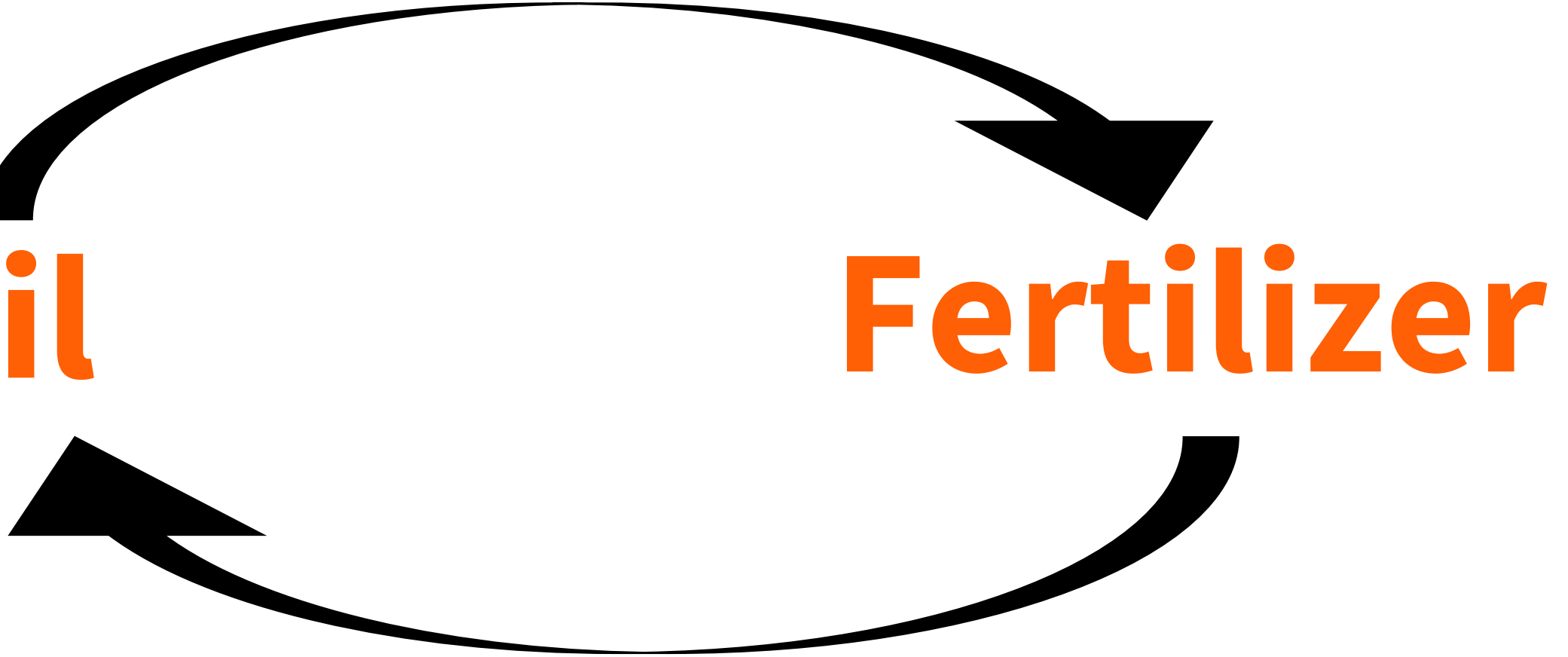
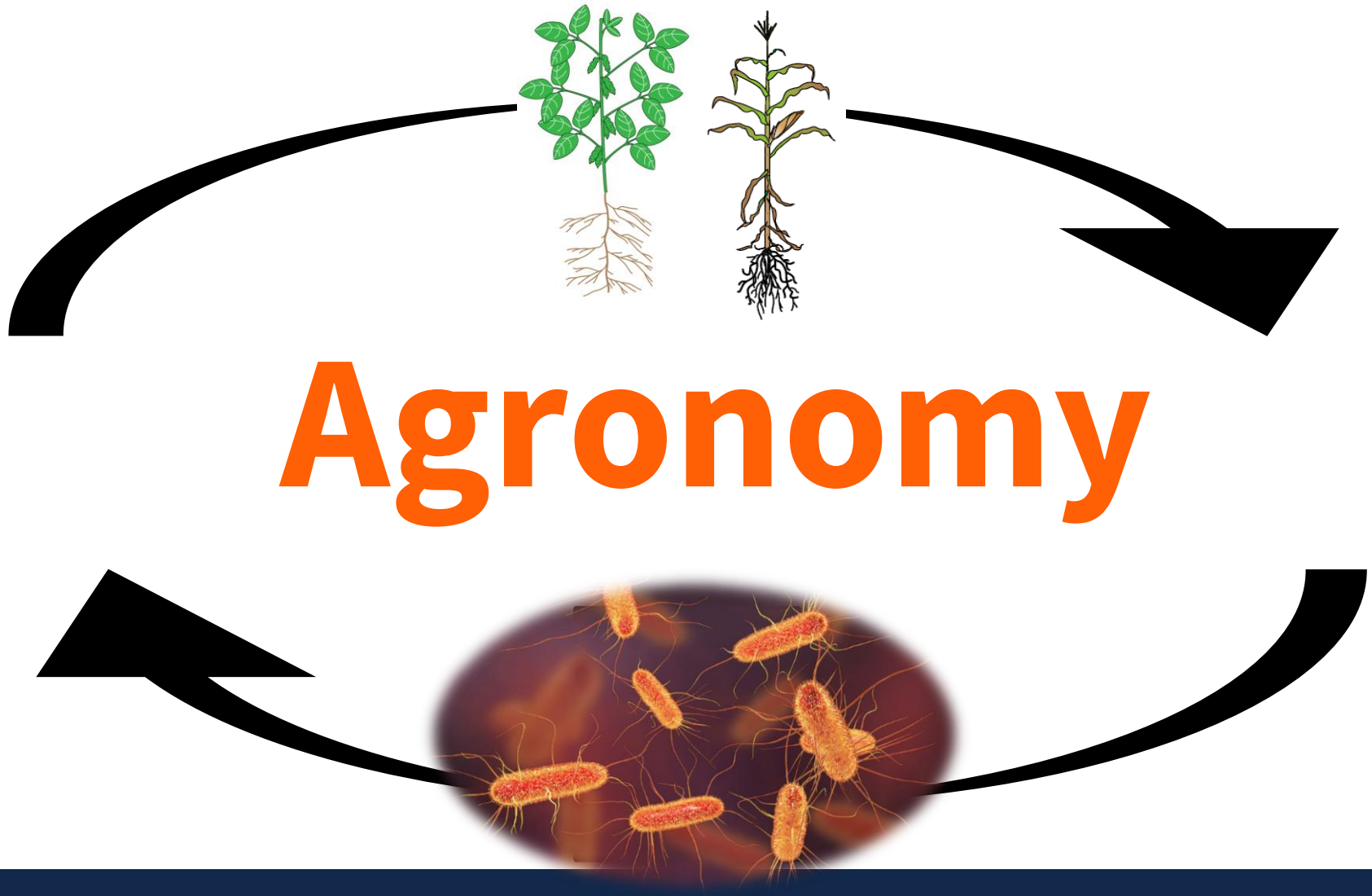
Crop Physiology

How do we traditionally think about crop nutrition?



Understanding Nutrient Cycling



Changing Perspectives

There is a New Shift to Biology Based Systems > Chemical Based

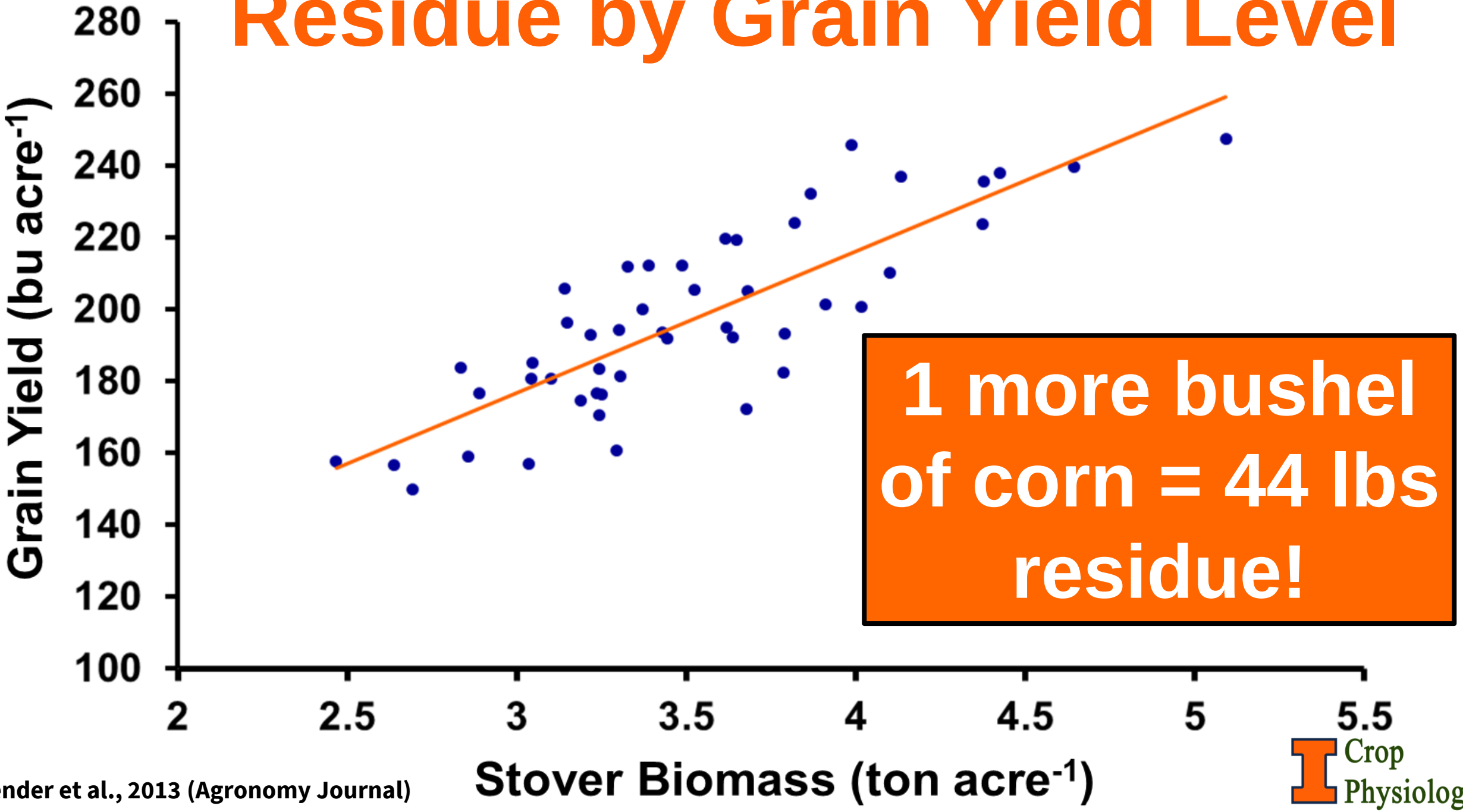
Where does residue come from?

Cover Crops (cereal rye)

Double Crops

Higher Yields

Residue by Grain Yield Level



1 more bushel of corn = 44 lbs residue!

Bender et al., 2013 (Agronomy Journal)

Crop Physiology

Corn Residue by Yield Level

Grain Yield	Stover Accumulation
bu acre^{-1}	ton acre^{-1}
180	3.9
250	5.5
300	6.6
616	13.5

Assuming a harvest index of 52%

Crop Physiology

Is residue trash or treasure?

Crop Physiology

Too Much Residue Can be a Problem

Crop Physiology

The Nutritional Value of Corn Residue

"Treasure"

Nutrient	Re	e
	lbs ton^{-1}	lbs acre^{-1}
N	20	108
P_2O_5	4	21
K_2O	23	122

Assuming grain yield of 230 bu acre^{-1} and 5.4 tons residue acre^{-1}.
Agron. J. 105:161-170 (2013).

Crop Physiology

What can one do to ‘unlock’ the value of their residue?

Crop Physiology

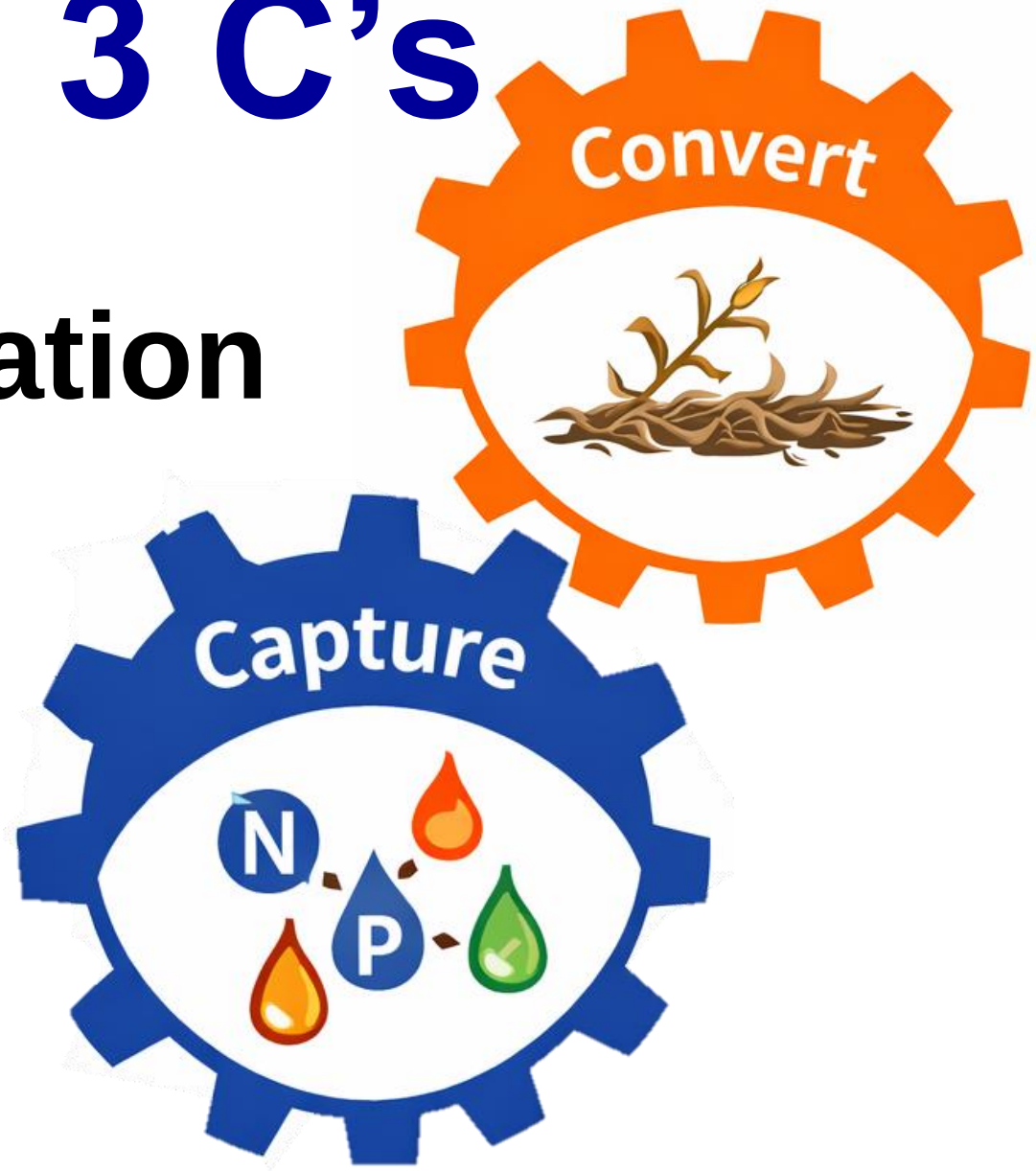
The 3 C's

The 3 C's

- **Convert**
  - **Residue Degradation**

The 3 C's

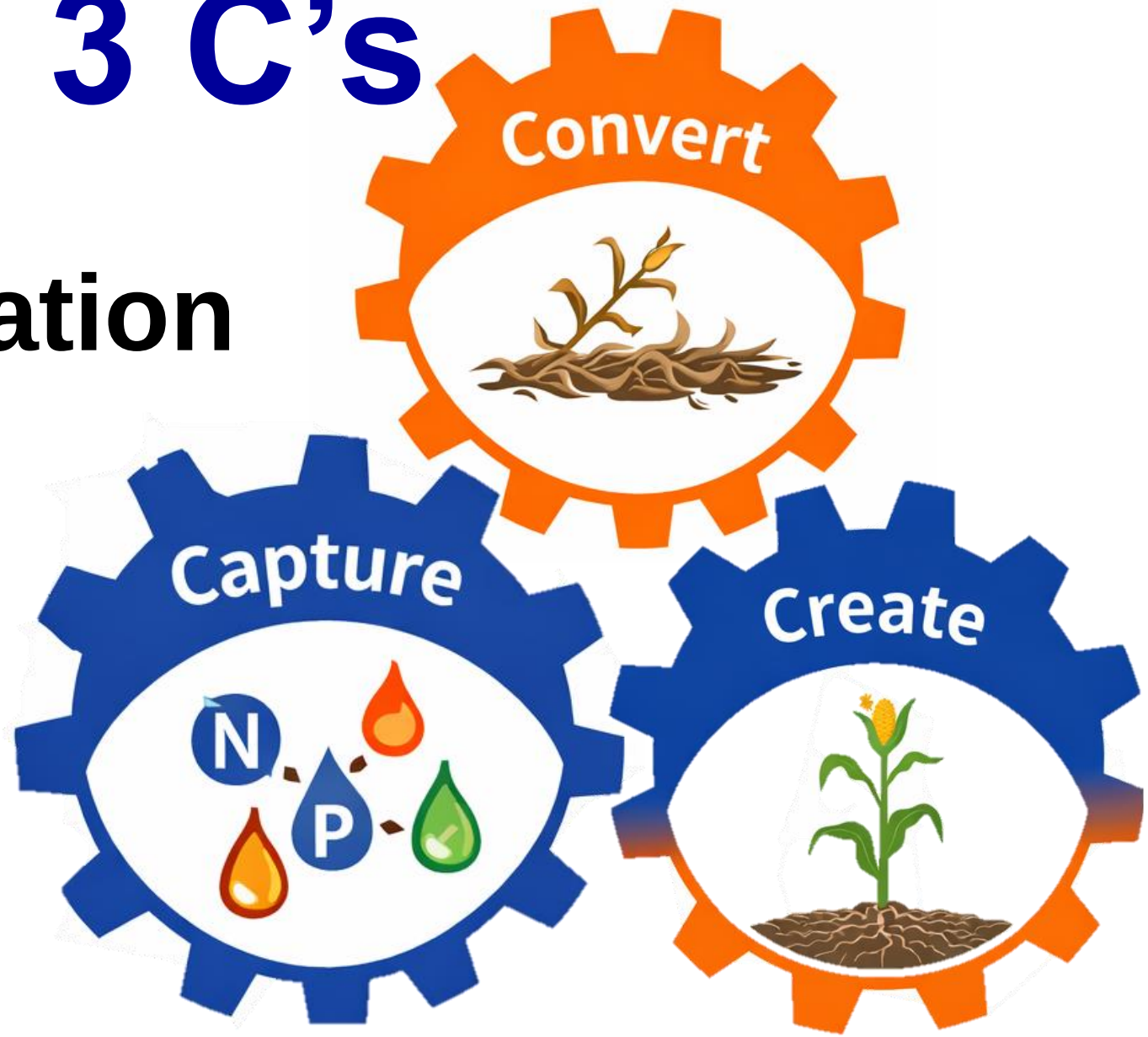
- **Convert**
  - **Residue Degradation**
- **Capture**
  - **Nutrient Value**



Crop Physiology

The 3 C's

- Convert
  - Residue Degradation
- Capture
  - Nutrient Value
- Create
  - Increase Yield

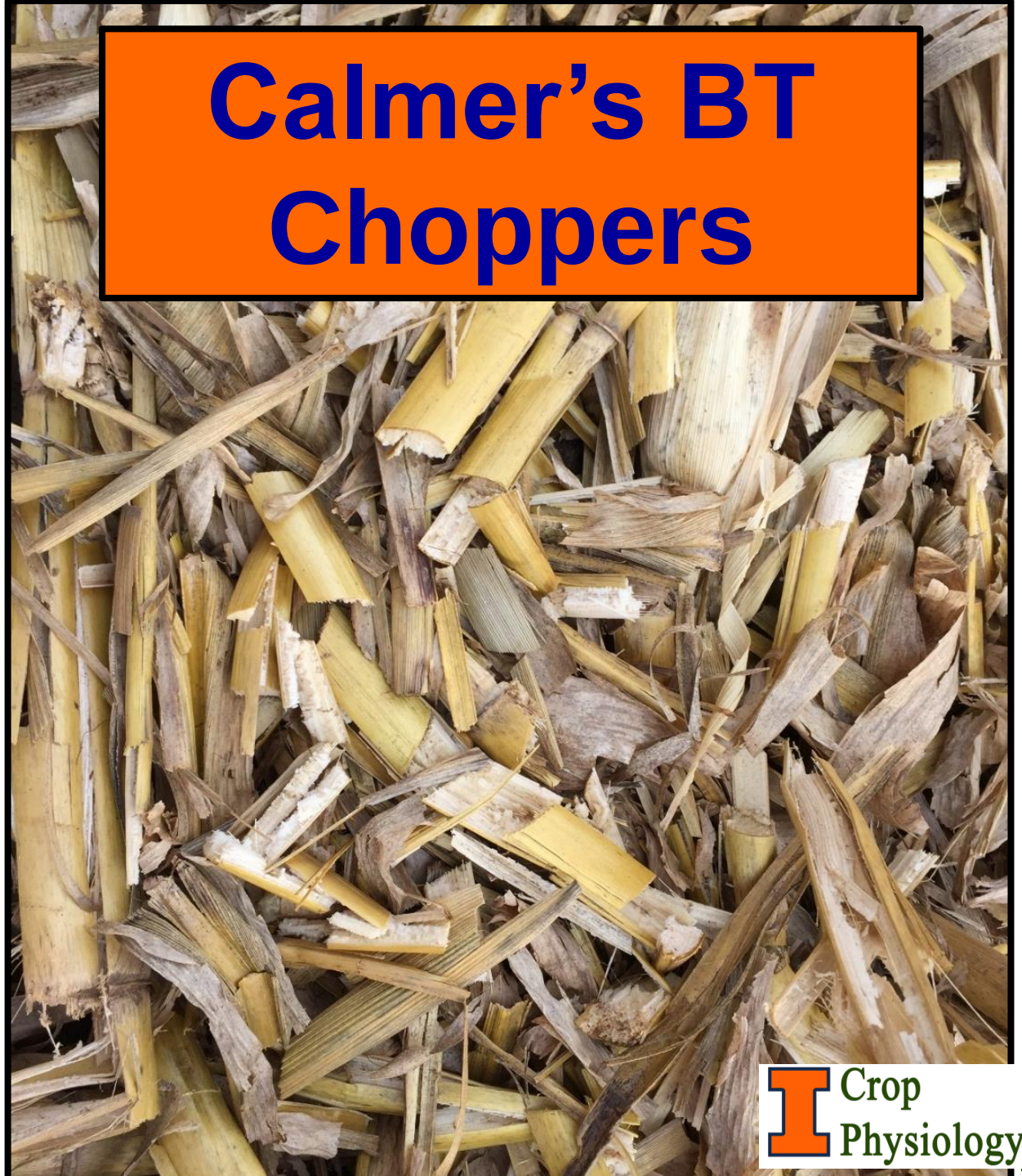


Crop Physiology

Let's start with the combine – mechanical management

Crop Physiology


Standard Stalk Rollers


Calmer's BT Choppers
Crop Physiology

Residue has been mechanically sized, is that enough?

Crop Physiology

Fall Fertility Applications

Ammonium Sulfate (21-0-0-24S)

200 lb/acre = 42 lb N, 48 lb S

Crop Physiology

Common C:N Ratios

Residue	C:N Ratio	
Rye Straw	82:1	Induces N immobilization
Wheat Straw	80:1	
Corn Stover	57:1	
Rye Cover Crop (vegetative)	26:1	
Alfalfa	25:1	
Clover	20:1	Induces N mineralization
Hairy Vetch	11:1	
Soil Microorganisms	8:1	

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250 bu/acre = 5.5 tons!!

Induces N immobilization

Induces N mineralization

Harvest Method x AMS Grain Yields

Harvest Method	Fertility	Conventional Till 2017	Conventional Till 2018	No-Till 2020	No-Till 2021	Avg.
		bu acre^{-1}				
Standard	None	**175**	**215**	**180**	**176**	**187**
	Fall AMS	**181**	**218**	**185**	**184**	**192**
	Δ	**+ 6**	**+ 3**	**+ 5**	**+ 8**	**+ 5**
Chopped	None	**181**	**224**	**183**	**178**	**192**
	Fall AMS	**185**	**223**	**187**	**183**	**195**
	Δ	**+ 4**	**- 1**	**+ 4**	**+ 5**	**+ 3**

Averaged across hybrid, input, and crop rotation of corn-corn and corn-soybean.

Common C:N Ratios

Residue	C:N Ratio
Rye Straw	82:1
Wheat Straw	80:1
Corn Stover	57:1

Induces N immobilization

Corn Stalks Can Have a Carbon to Sulfur Ratio of ~350:1

Key Takeaway

Adding fertility to the residue improves decomposition and subsequent grain yields regardless of mechanical management.

Microbes need nutrients too!

Crop Physiology

Residue and the C:N Ratio

- C:N is source dependent
- Soil microbes like a C:N Ratio of 24:1
  - Microbes have a C:N ratio of 8:1
  - 16 C for energy, 8 for maintenance
- C:N ratio > 24:1 induces N immobilization
- C:N ratio < 24:1 induces N mineralization

How can we manage residue?

Mechanical Sizing of Residues

Fertility N and/or S

Fall burndown application with a bacterial blend

What are Biologicals?

- **Beneficial Microbes**

"The Living"

- **Biostimulants**

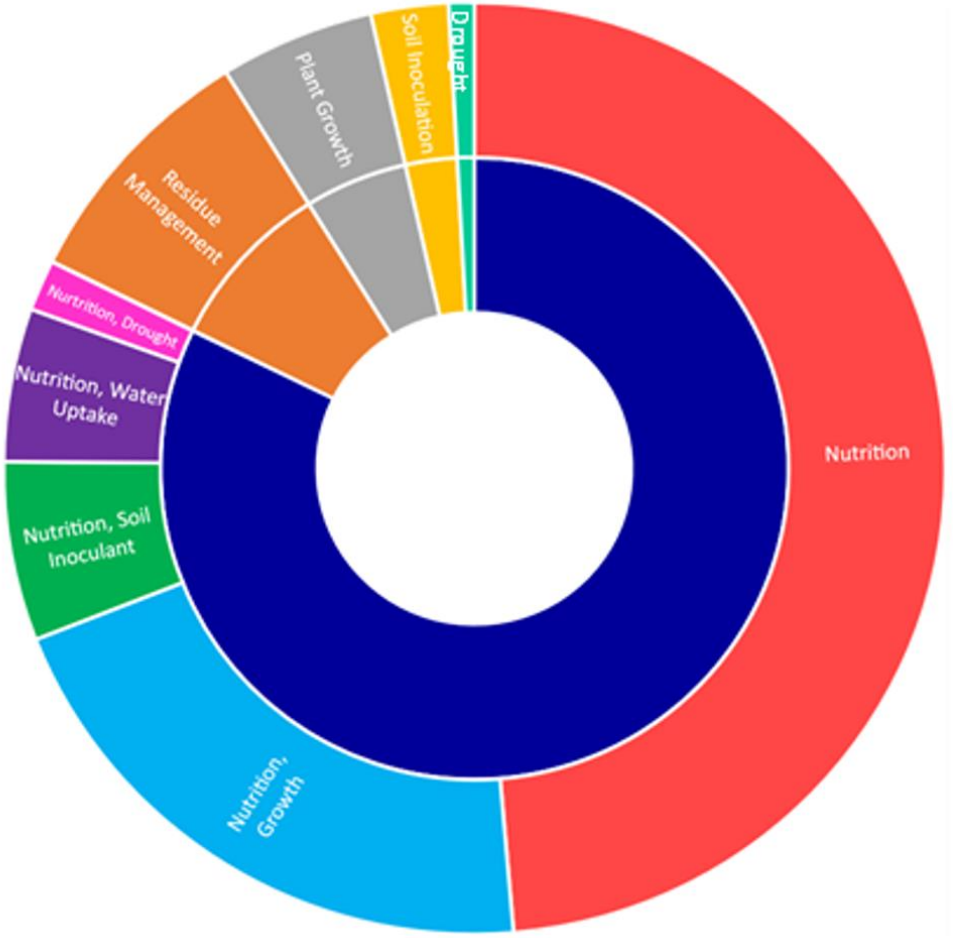
"The Dead"

What are Biologicals?

- **Beneficial Microbes**

"The Living"

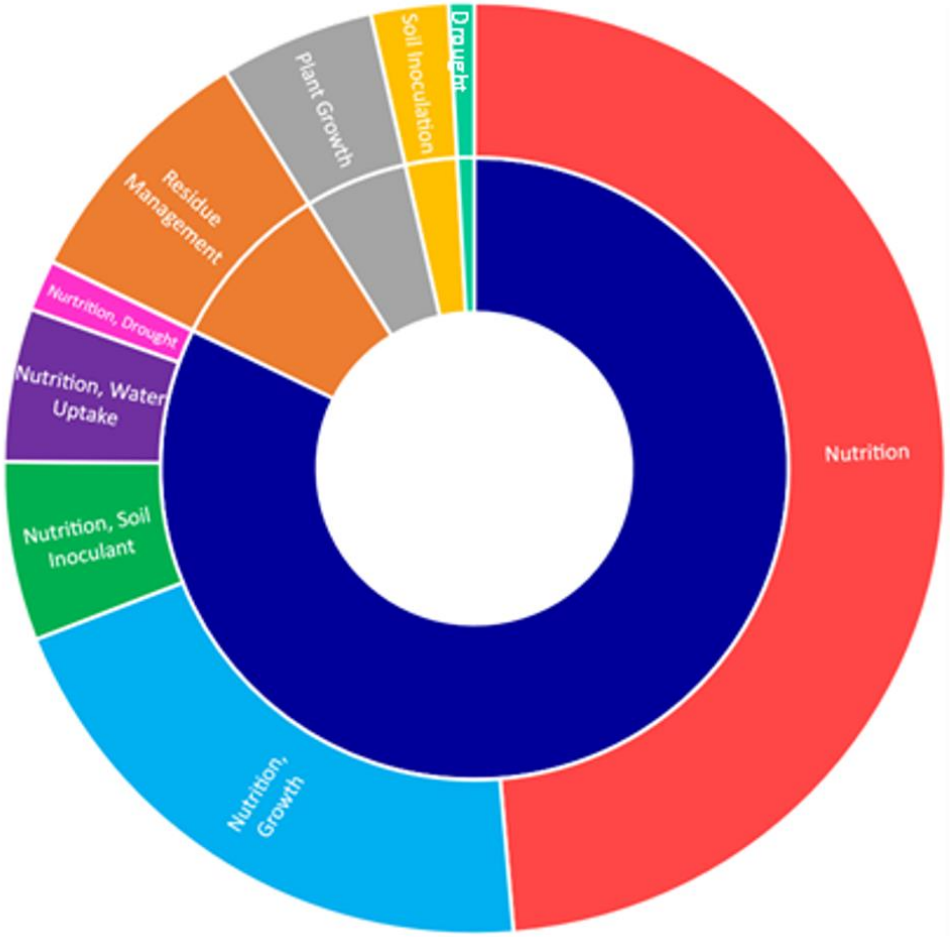
What do those microbes do?



155 Products Surveyed

- ***82% Crop Nutrition***
- ***9% Residue Management***
- ***5% Plant Growth***
- ***3% Soil Inoculant***
- ***1% Drought Tolerance***

What do those microbes do?



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Can multiple approaches to crop residue management be synergistic?

Crop Physiology

Long-Term Continuous Corn, A Case Study

Crop Physiology

Trial Design and Site Characteristics

- **Long-term continuous corn site established in 2003**

Crop Physiology

Trial Design and Site Characteristics

- **Long-term continuous corn site established in 2003**
- **Studies conducted in 2020 and 2021 on 17th and 19th year continuous corn**

Crop Physiology

Managing the CCYP – 2 Year Results

Management	Yield	CCYP
	—bushels per acre —	
Corn-Soybean Rotation	201	-
Long-Term Continuous Corn	153	48

Sible et al., 2024 (SSSAJ)

Crop Physiology

Managing the CCYP – 2 Year Results

Management	Yield	CCYP
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Long-Term Continuous Corn	153	48
+ Chopped Residues	166	35 + 13

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Crop Physiology

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+ Ammonium Sulfate (AMS)	167	34 + 1

Sible et al., 2024 (SSSAJ)

Crop Physiology

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+ Ammonium Sulfate (AMS)	167	34 + 1
+ Microbial Blend	178	23 + 11

Sible et al., 2024 (SSSAJ)

Crop Physiology

Managing the CCYP – 2 Year Results

Management	Yield	CCYP

A 52% Reduction in the CCYP

Any combination of practices was better than any individual practice by itself.

Sible et al., 2024 (SSSAJ)

Where does residue come from?

Cover Crops (cereal rye)

Double Crops

Higher Yields

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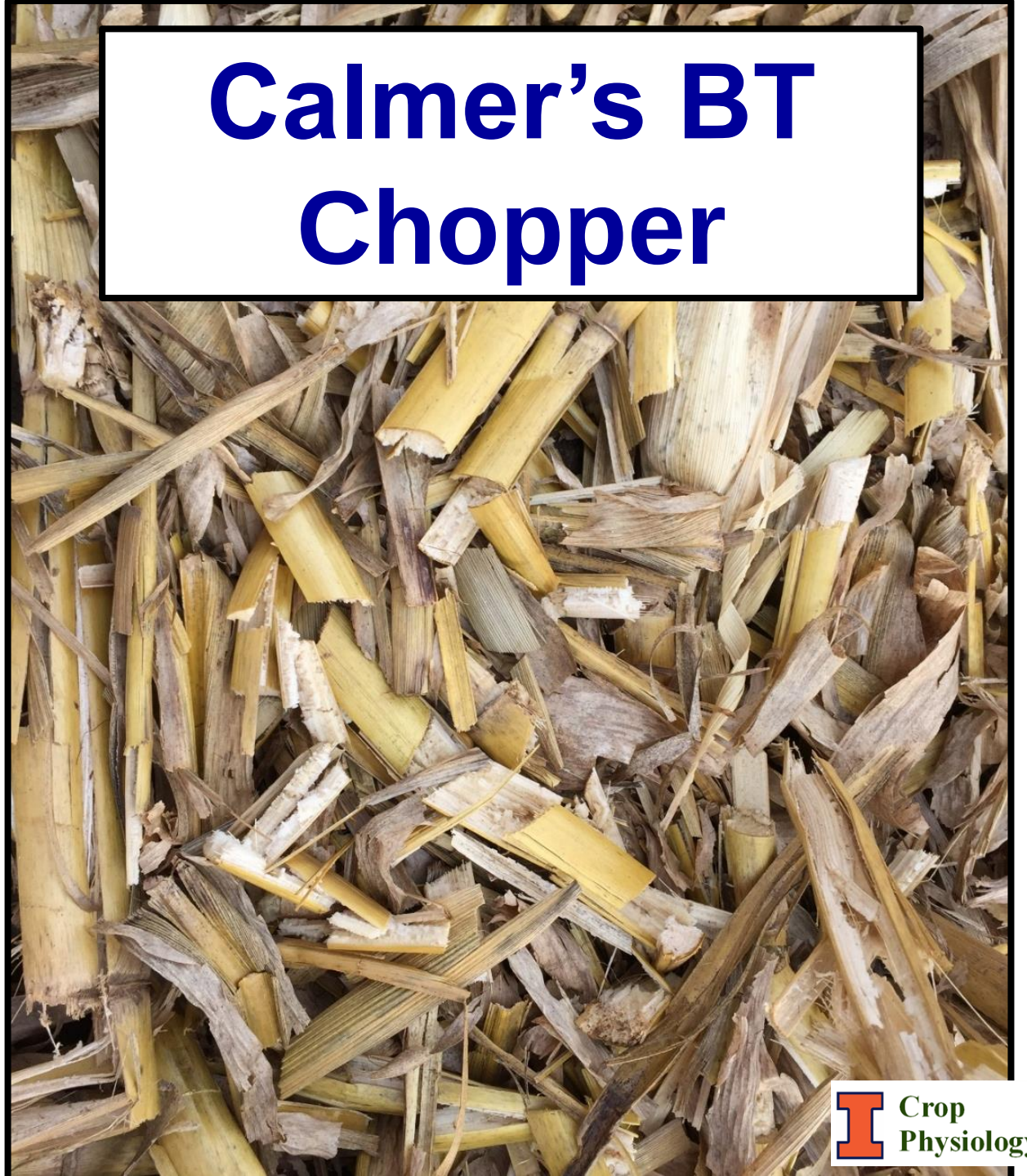
Crop Physiology

Do these approaches work in cover crop systems?

Illinois NREC Funded Study

Cover Crop Treatments

Corn Harvest Method	Cover Crop	Sulfur	Biological
Standard Stalk Rollers	X		
Calmer BT Super Chopper			



Crop Physiology

Does harvest method effect cover crop establishment?

Do biological treatments increase the rate of biomass degradation and/or nutrient release?

Crop Physiology

Cover Crop Treatments

Corn Harvest Method		Cover Crop
Standard Stalk Rollers	X	None
Calmer BT Super Chopper	X	Cereal Rye (ahead of soy) or Crimson Clover (ahead of corn

Cover Crop Treatments

Corn Harvest Method		Cover Crop		Sulfur		Biological
Standard Stalk Rollers	X	None	X	None		
Calmer BT Super Chopper		Cereal Rye (ahead of soy) or Crimson Clover (ahead of corn		ATS / AMS		

Cover Crop Treatments

Corn Harvest Method		Cover Crop		Sulfur		Biological
Standard Stalk Rollers	X	None	X	None	X	None
						Living Blend
Calmer BT Super Chopper		Cereal Rye (ahead of soy) or Crimson Clover (ahead of corn		ATS		Carbon Blend
				AMS		None

Active Ingredients

Living	Non-Living
Bacillus amyloliquefaciens	**Sugar**
Bacillus licheniformis	**+**
Bacillus megaterium	**Humic Acid**
Bacillus pumilus	
Bacillus coagulans	
Phanerochaete chrysosporium	
Trichoderma harzianum	

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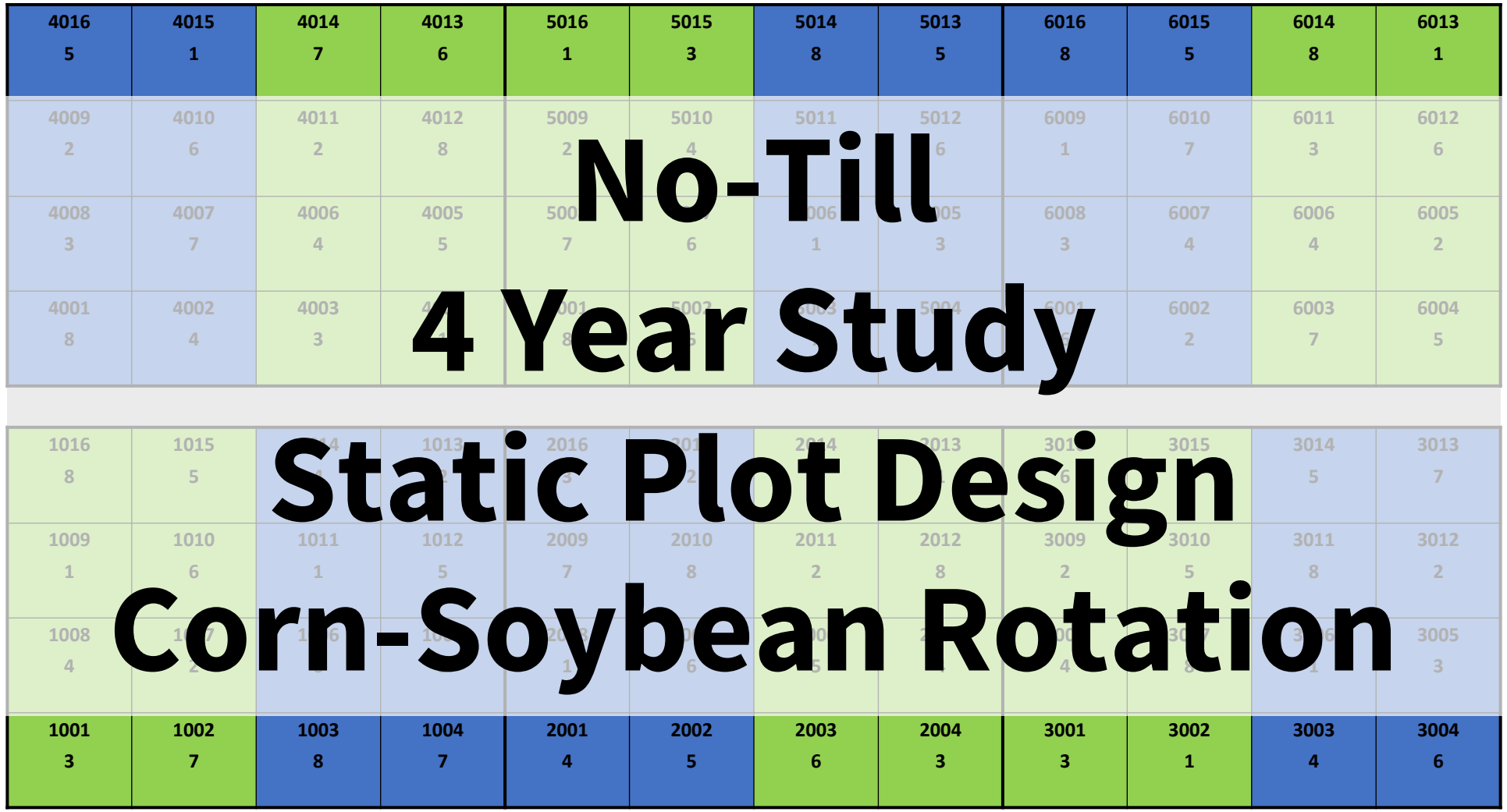
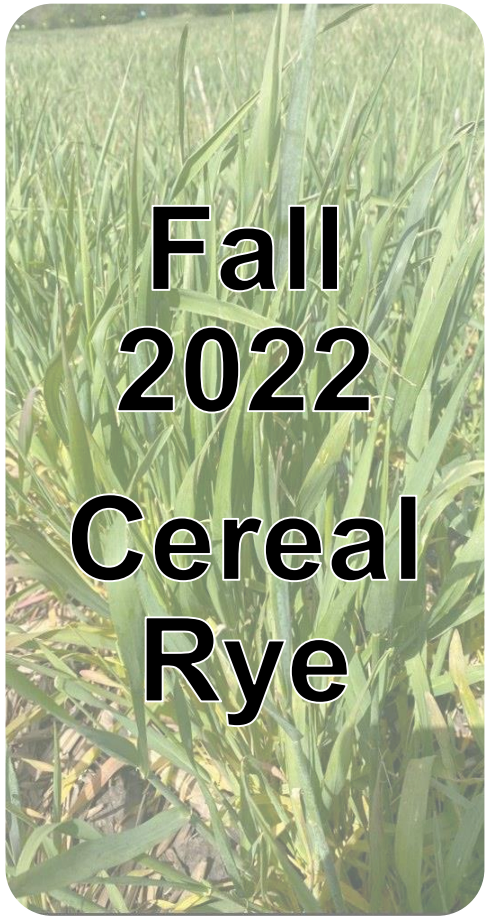
NREC Study Approach



Crop Physiology

Trial Timeline



Crop Physiology

2023 Cover Crop Trial Information

Soil Test

OM	CEC	pH	P†	K	Ca	Mg	S	Zn	Mn	B
%	meq/100g	units	ppm							
5.3	27.1	6.0	54	165	3359	654	9.9	2.4	18	0.6

† Mehlich-3 extraction

- Cover Crop Planting Date → October 21st, 2022
- Cover Crop Termination → April 24th, 2023, with glyphosate
- Soybean Planting Date → May 15th, 2023
- Variety → AG33XF3
- Population → 140,000/A
- Harvest Date → October 9th, 2023

Crop Physiology

The Nutritional Value of Cereal Rye

Nutrient	Remaining in Residue	
	lbs ton^{-1}	lbs acre^{-1}
N	37	88
P_2O_5	14	33
K_2O	65	153

Assuming 2 tons residue acre^{-1}

Crop Physiology

Soybean Nutrient Requirement

Nutrient	Required to Produce 80 bu	Provided by Cover Crop	Nutrient Provided
	lbs/acre		%
N	327	88	27
P_2O_5	57	33	58
K_2O	227	153	67

Bender et al., (2015)

Main Effects of Sulfur on Cereal Rye Decomposition and Soybean Yield

Sulfur	R3	R7
	% Decomposition	
None	58.8	87.2
ATS	56.2	84.9
LSD (0.1)	1.5	NS

Crop Physiology


With ATS
Without ATS
Crop Physiology

Main Effects of Biologicals on Cereal Rye Decomposition and Soybean Yield

Biological	R3	R7
	% Decomposition	
None	55.9	84.1
Living Microbial Blend	56.9	86.3
Carbon Blend	59.7	87.8
LSD (0.1)	1.8	NS

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Cereal Rye Decomposition

- **ATS burns residue, reduces total decomposition**
- **Biologicals increase mid-season decomposition**

Trial Timeline

Fall 2022 Cereal Rye

Spring 2023 Soybean

Crop Physiology

2024 Cover Crop Trial Information

Soil Test

OM	CEC	pH	P†	K	Ca	Mg	S	Zn	Mn	B
%	meq/100g	units	ppm							
5.3	27.1	6.0	54	165	3359	654	9.9	2.4	18	0.6

† Mehlich-3 extraction

- Cover Crop Planting Date → October 11th, 2023
- Cover Crop Termination → May 1st, 2024, with glyphosate+dicamba
- Corn Planting Date → June 3rd, 2024
- Hybrid → DKC111-33
- Population → 36,000/A
- Harvest Date → October 31st, 2024

Crop Physiology


Clover Cover Crop

The Nutritional Value of Clover

Nutrient	Remaining in Residue	
	lbs ton^{-1}	lbs acre^{-1}
N	46	92
P_2O_5	12	24
K_2O	66	132

Assuming 2 tons residue acre^{-1}

Crop Physiology

Corn Nutrient Requirement

Nutrient	Required to Produce 230 bu	Provided by Cover Crop	Nutrient Provided
	lbs/acre		%
N	256	92	36
P_2O_5	101	24	24
K_2O	180	132	73

Bender et al., (2013)

2023-2025 Grain Yields

Treatment	Grain Yield		
	23’ Soy	24’ Corn	25’ Soy
	bushels/acre		
UTC	87	262	76
Cover Crop			
+ Microbial Blend			
+ Carbon Blend			
+ ATS			
+ ATS + Microbial Blend			
+ ATS + Carbon Blend			
LSD (.05)			

ATS; ammonium thiosulfate applied at 7 gal/acre to supply 20 lb S/acre

Crop Physiology

2023-2025 Grain Yields

Treatment	Grain Yield		
	23’ Soy	24’ Corn	25’ Soy
	bushels/acre		
UTC	87	262	76
Cover Crop	81 -6	254 -8	75 -1
+ Microbial Blend			
+ Carbon Blend			
+ ATS			
+ ATS + Microbial Blend			
+ ATS + Carbon Blend			
LSD (.05)	4	8	NS

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Crop Physiology

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Crop Physiology

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+ ATS	87 +6	257 +3	77 +2
+ ATS + Microbial Blend	87 +6	261 +7	78 +3
+ ATS + Carbon Blend	87 +6	264 +10	79 +4
LSD (.05)	4	8	NS

ATS; ammonium thiosulfate applied at 7 gal/acre to supply 20 lb S/acre

Crop Physiology

In Summary – Trial Results

- **Cover crops can be managed at termination to enhance breakdown and minimize yield penalty**
- **Nitrogen/sulfur source is currently the best single management approach**
  - **Some compatibility concerns with herbicide and ATS**
- **Biologicals provide some benefit, but add additional gain when supplied with a fertility source**

Key Takeaways

- **Enhancing residue decomposition and nutrient release accelerates the nutrient cycle in a given season…**
- **This efficiency results in higher yields, and thus higher grain nutrient removals**
- **Must manage fertility plans to ensure the long-term sustainability of these systems (cannot mine our soils)**

What are we looking at for future avenues of residue management?

Crop Physiology

Key Grower Questions

- **Is corn residue management better for soybean or 2nd year corn?**
- **Should residue digesters be tilled in after application?**

Crop Physiology

Key Grower Questions

- **Does a little bit of N or S help increase activity of applied biologicals?**
- **Does timing of application increase biological activity?**
- **Does re-applying year after year have compound effects?**

Crop Physiology

Trial Timeline

Fall 2025

Corn Stalks

Summer 2026

2nd Year Corn or 1st Year Soybean

Summer 2027

3rd Year Corn or 1st Year Corn

Summer 2028

4th Year Corn or 1st Year Soybean

Crop Physiology

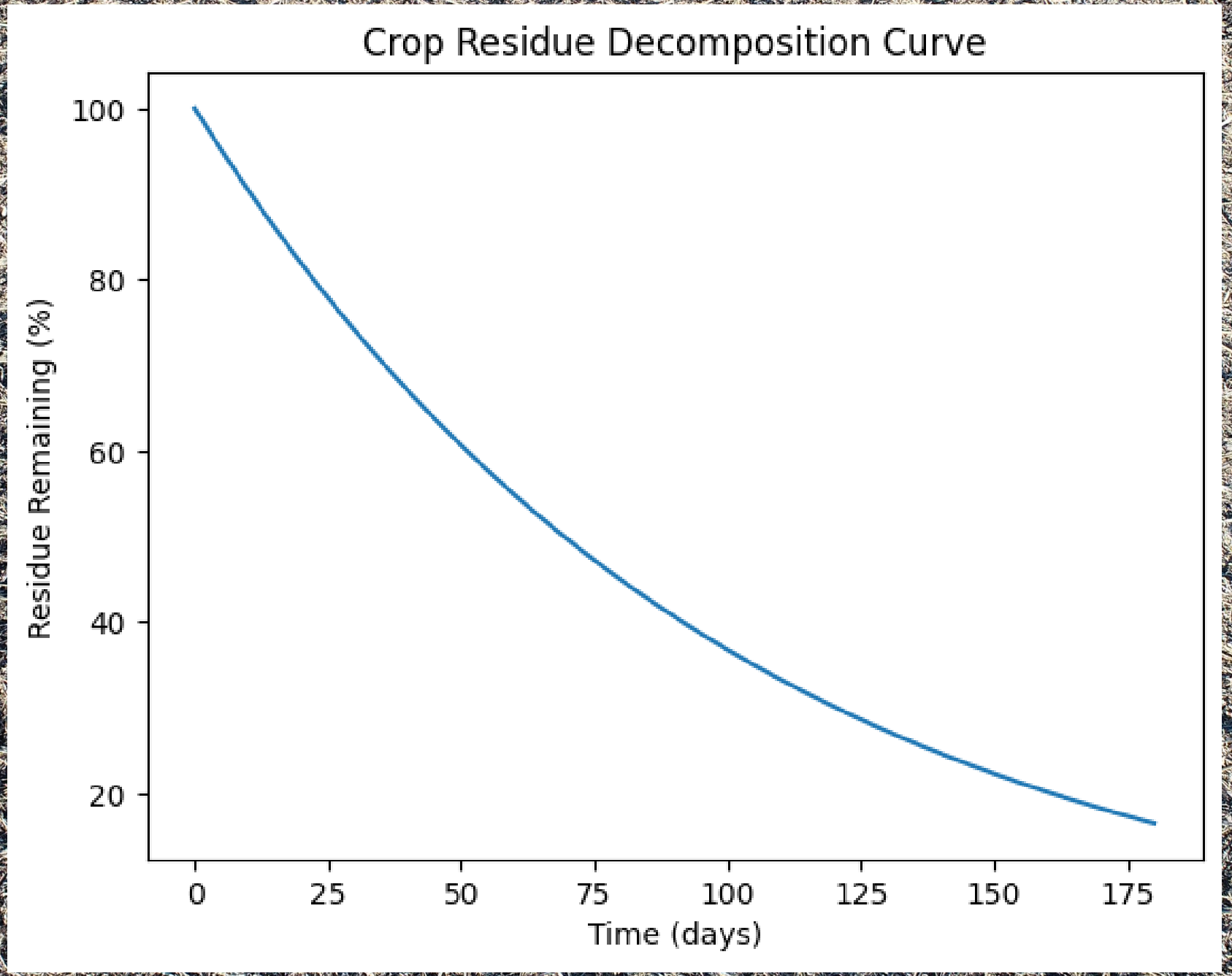
Fall 2025 – Residue Trial

Crop Rotation	Tillage	Nitrogen	Biological	Application Timing
Corn-Soy	No-Till	None	None	Fall
×	×	×	×	
Corn-Corn	Conventional	UAN (3 gal)	Microbe	Spring

Fall 2025 – Residue Trial

Crop Rotation		Tillage		Nitrogen		Biological
Corn-Soy	×	No-Till	×	None	×	None
Corn-Corn		Conventional		ATS (3.5 gal)		Microbe
				UAN (1.5 gal)		

Residue Sampling


Crop Residue Decomposition Curve
Residue Remaining (%)
100
80
60
40
20
0
25
50
75
100
125
150
175
Time (days)

Results……
Coming Fall of 2026

Special Thank You to Illinois Soybean Association and Field Advisor!

More info at:

Crop Physiology Laboratory

University of Illinois

http://cropphysiology.cropsci.illinois.edu

Crop Physiology