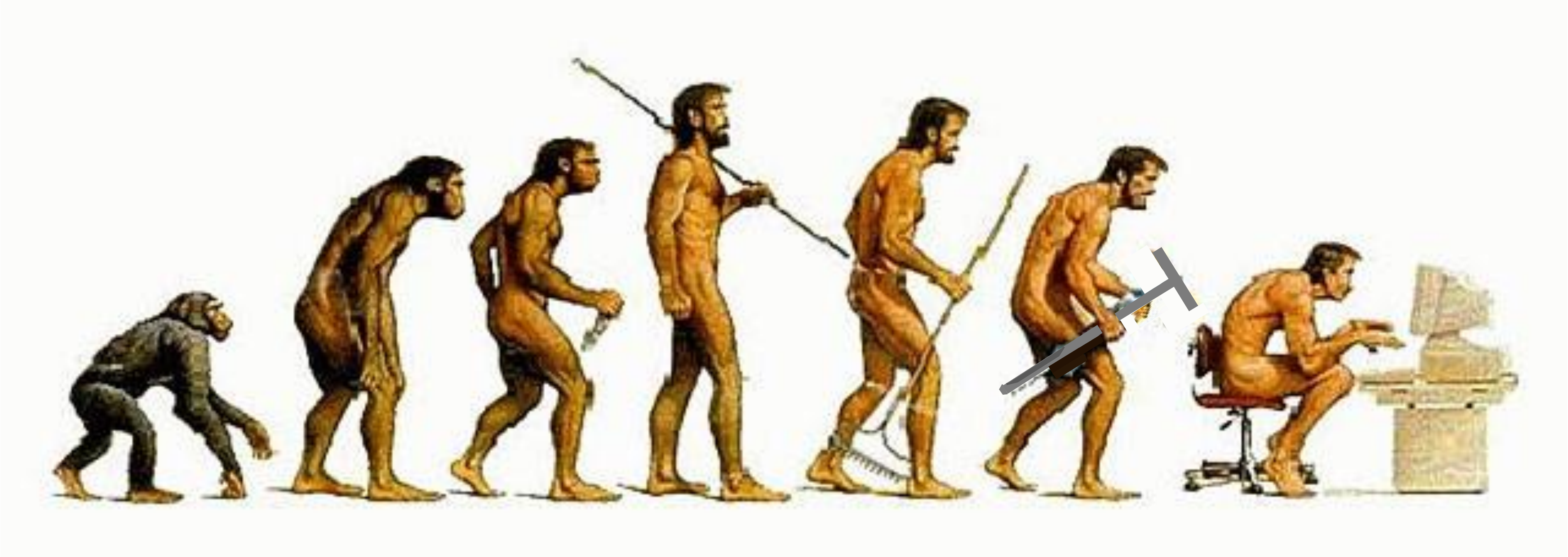
Best Predicting Corn N Needs: *To Sample or Not to Sample?*



Marshall McDaniel
Associate Professor in Soil-Plant Interactions | Agronomy | Iowa State University
2022 ALTA Summer Meeting| Des Moines, IA 2022

Outline: Best Predicting Corn N Needs

1. **Background and Problem**

2. **Novel soil N testing**

   Case Study A: CO_2 Burst

   Case Study B: multi-test approach

3. **The future of N fertilizer recommendations**

   (and role of soil/plant sampling and analysis)

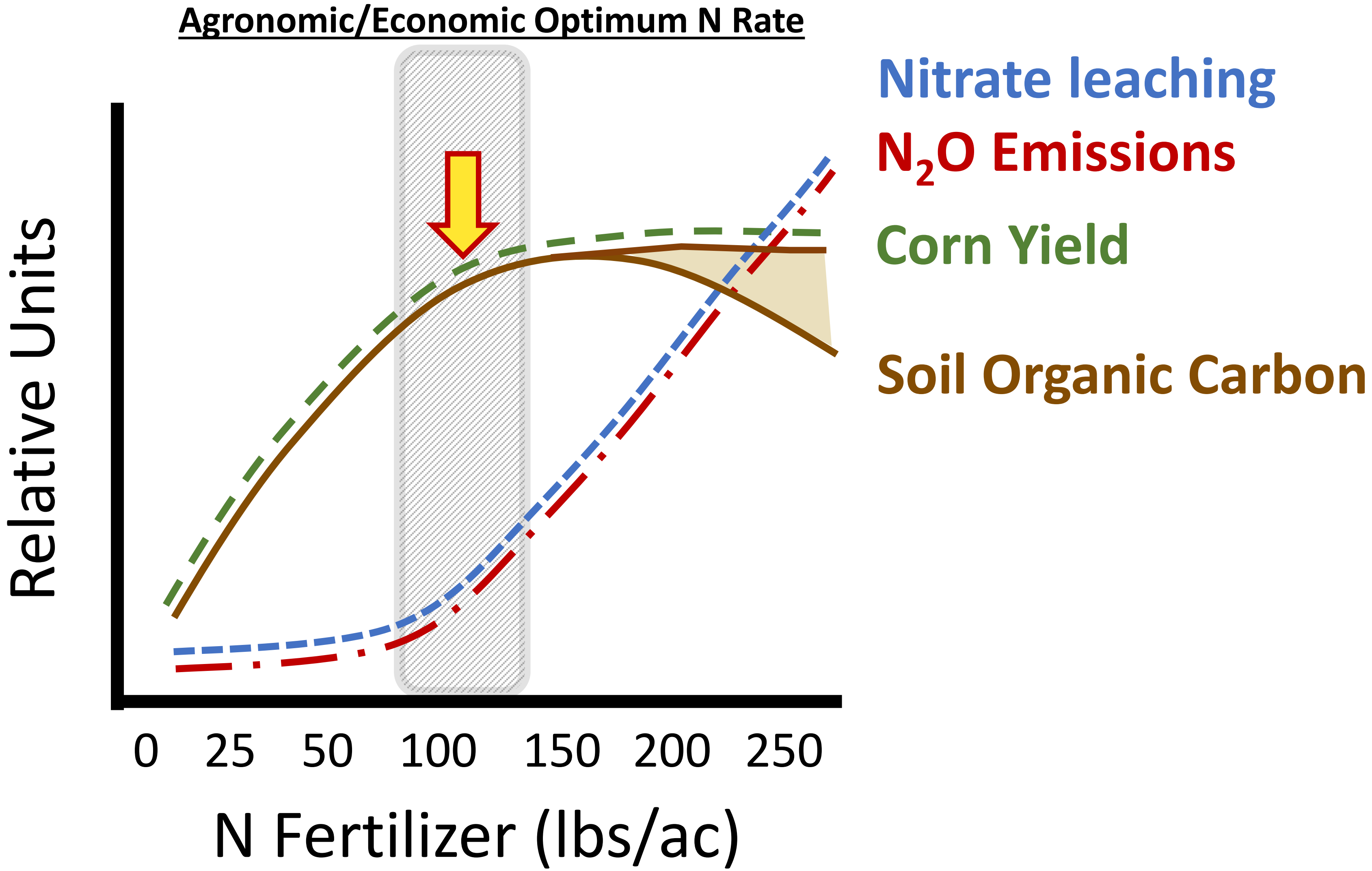
McDaniel Lab

Soil-Plant IXNs

Email: marsh@iastate.edu

: @Soil_Plant_IXNS

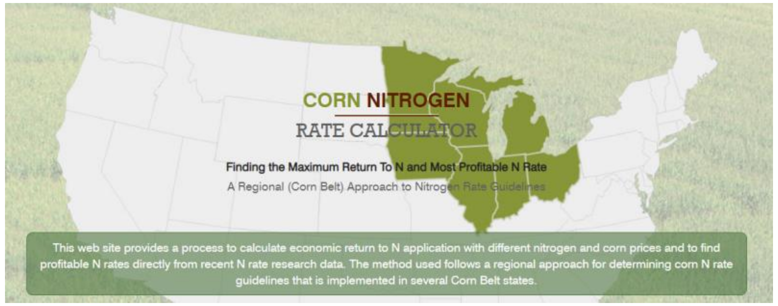
Predicting crop N needs has never been more important!



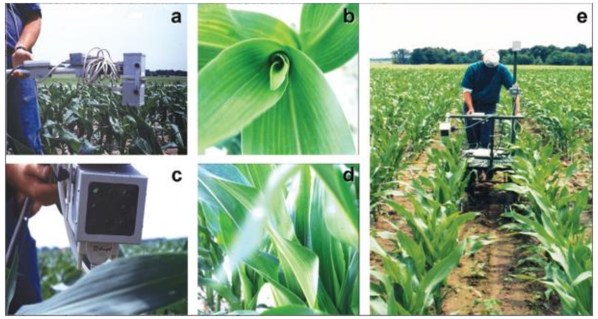
There are many possible ways farm operators can decide on N fertilizer rate to apply

- ✓ The "1.2 Rule" (or "yield goal")
- ✓ The Nitrogen Rate Calculator (MRTN)
- ✓ Cornstalk Nitrate Test
- ✓ Soil testing (e.g. LSNT or PSNT)
- ✓ Crop/Canopy Sensing
- ✓ Guessing???

Bullock 1990's



Blackmer et al. 1988;
Sawyer et al. 2017



Scharf et al. 2009

Are growers testing for N recommendations?

sustainability

2016

MDPI

Review

Are Australian and United States Farmers Using Soil Information for Soil Health Management?

Lisa Lobry de Bruyn [1,*] and Susan Andrews [2]

30% of US Farmers
(25% in Australia)

iowa farm and rural life poll

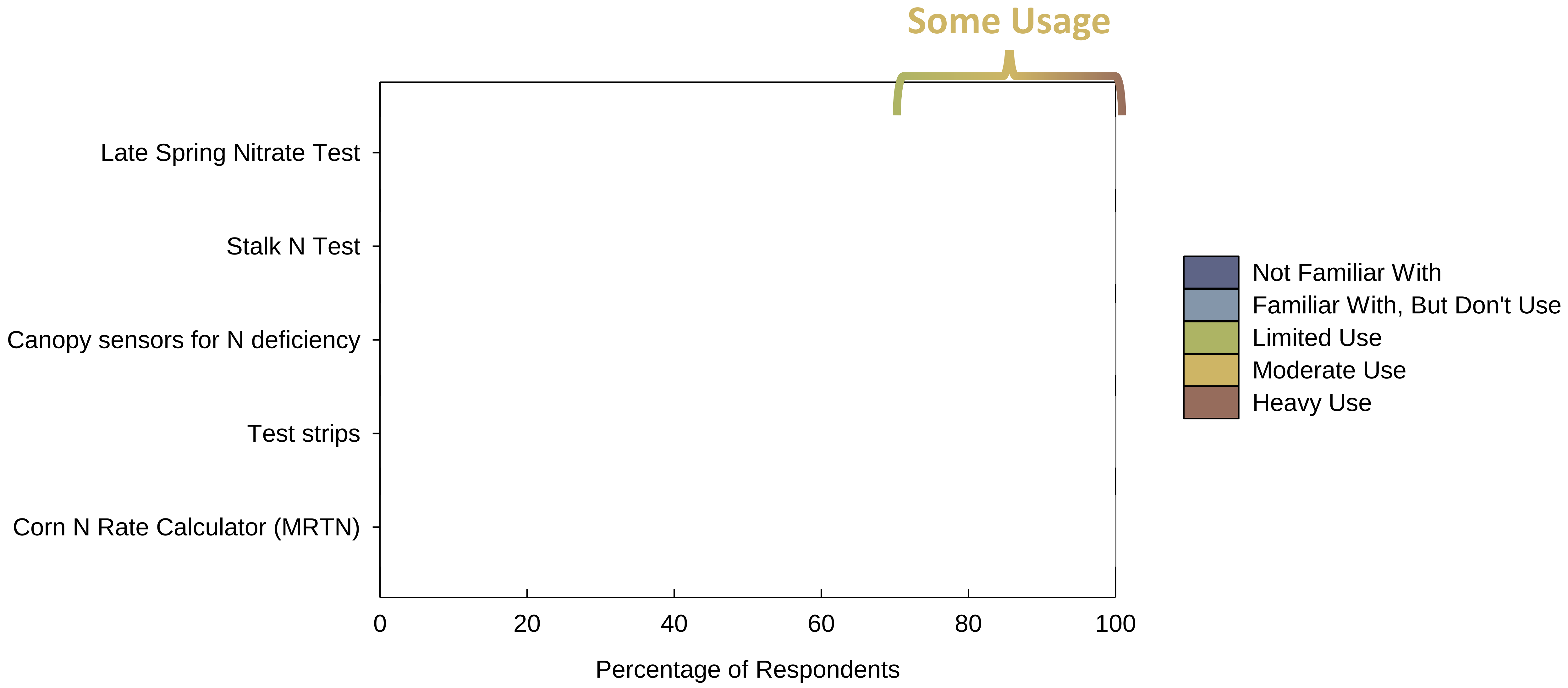
2012

Iowa Farmers' Nitrogen Management Practices and Perspectives

J. Arbuckle – Professor in Rural Sociology; Hanna Rosman – Graduate Student

2,219 Farm Operators Surveyed
(1,296 Responded – 58%)

Farmers aren't using extension N recommendations



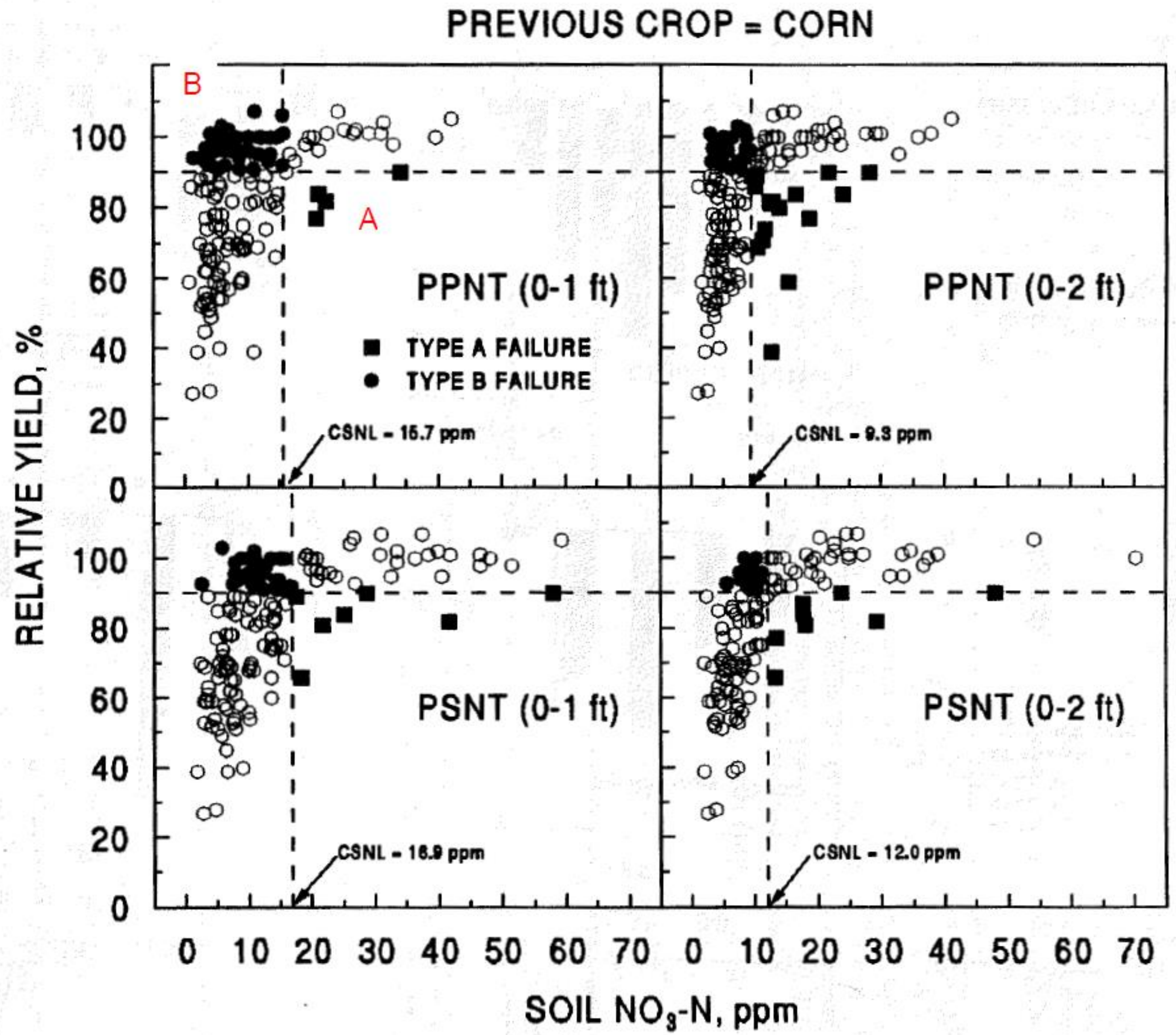
Arbuckle & Rosman (2014)_PM 3066

Novel Soil N Testing

Case Study A: CO_2 Burst

Case Study B: multi-test approach

Problems with LSNT (or PSNT)



TYPE A FAILURE

Tested high, but didn't apply enough N fertilizer

TYPE B FAILURE

Tested low, but over-applied N fertilizer

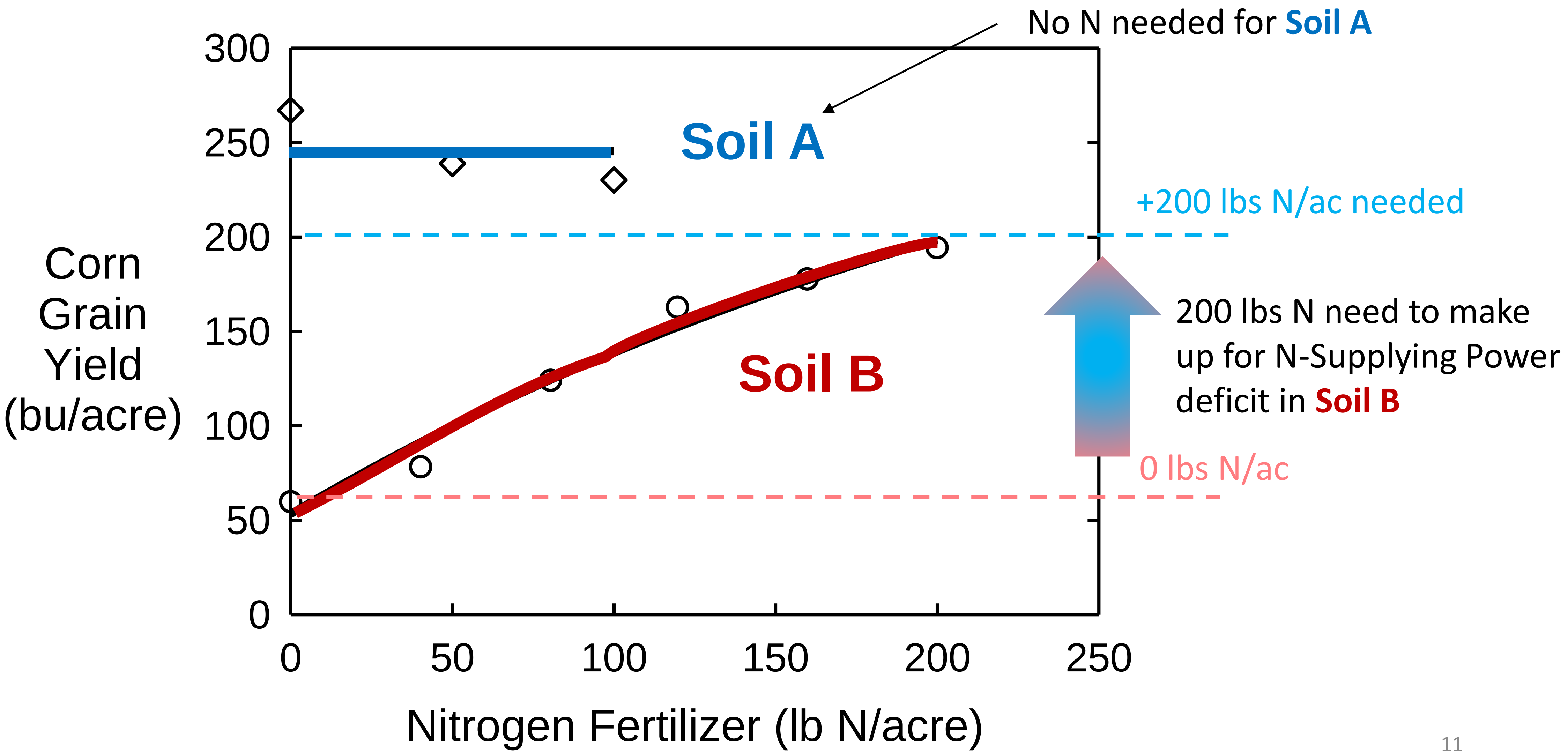
Bundy et al. 2002

New soil tests and/or technologies are needed to get the 'whole story' over the growing season

Sampling **soil extractable NO_3^-** once at the beginning of the year (e.g. LSNT) **is like seeing a picture** (or **snapshot**) of a movie and expecting to know the whole story!

Instead of looking at a snapshot, we should be at least looking at the movie trailer (or N-supplying power)

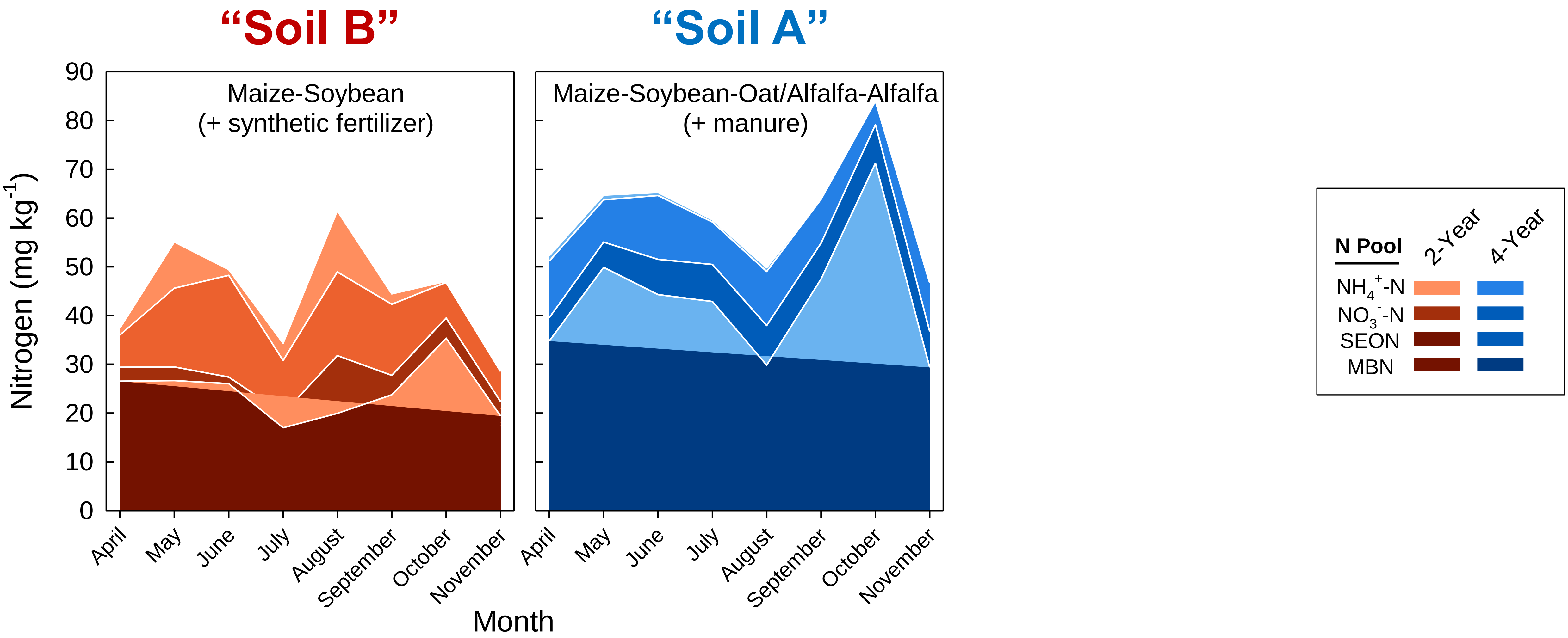
We need soil test that measures **N-Suppling Power**



Franzluebbers et al. 2018_SSSAJ

Case Study A

A tale of two soils (under corn)…



Baldwin-Kordick et al. 2020_ASFS

Measuring N-supplying power of soils

1. Measure a biological process

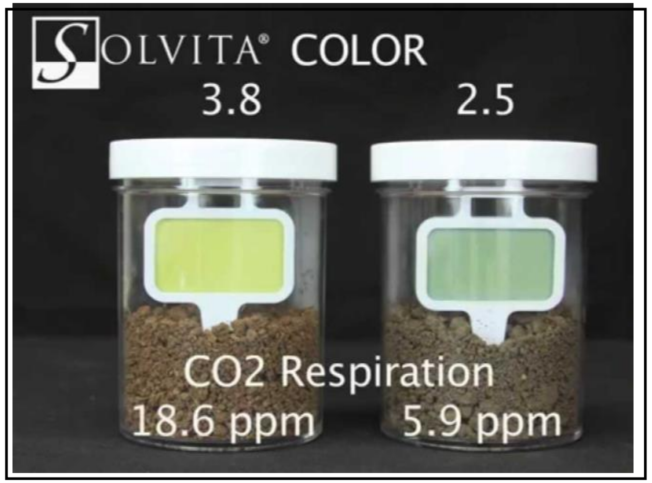
   e.g. 14-d aerobic incubation (Keeney and Bremner 1996) or CO_2 Burst (Franzluebbers et al. 2018)

2. Extract an organic form of N, that is mineralized over the growing season

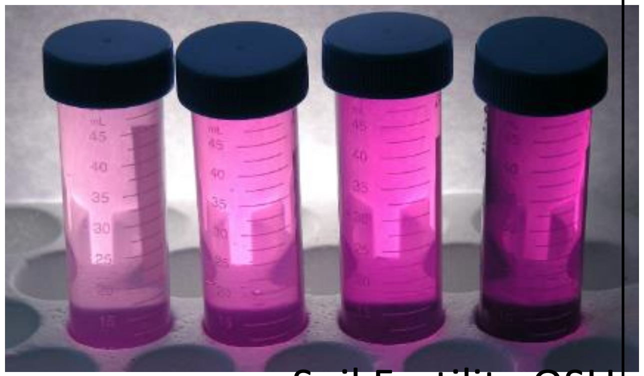
   e.g. Illinois Soil Nitrogen Test (Kahn et al. 2001) or Glomalin extraction (Hurisso et al. 2018)

3. Quantify labile or active SOM fraction

   e.g. permanganate oxidizable C (Culman et al. 2013)



Cornell



Soil Fertility OSU

Measuring N-supplying power of soils

1. Measure a biological process

   e.g. 14-d aerobic incubation (Keeney and Bremner 1996) or **CO_2 Burst (Franzluebbers et al. 2018)**

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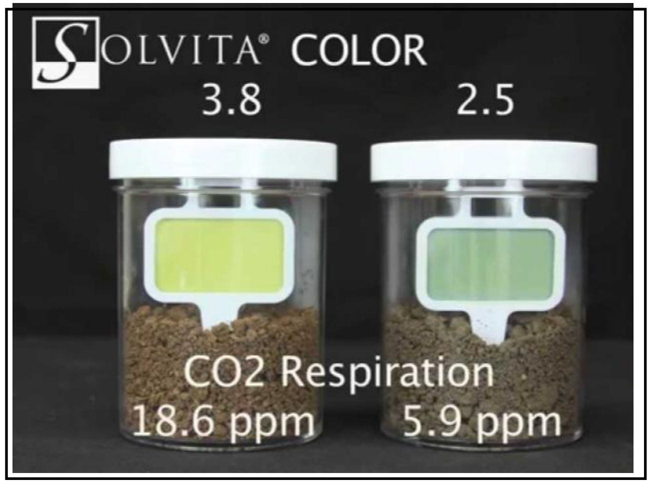
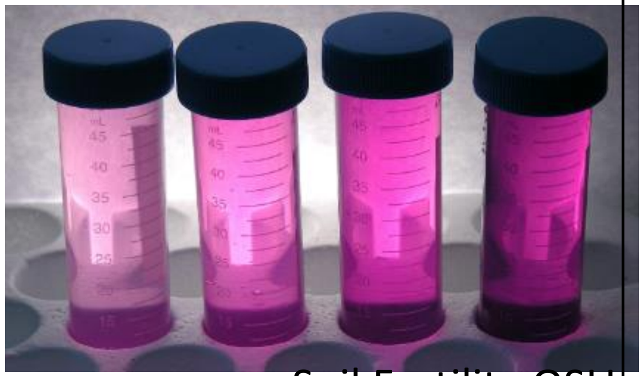


Cornell

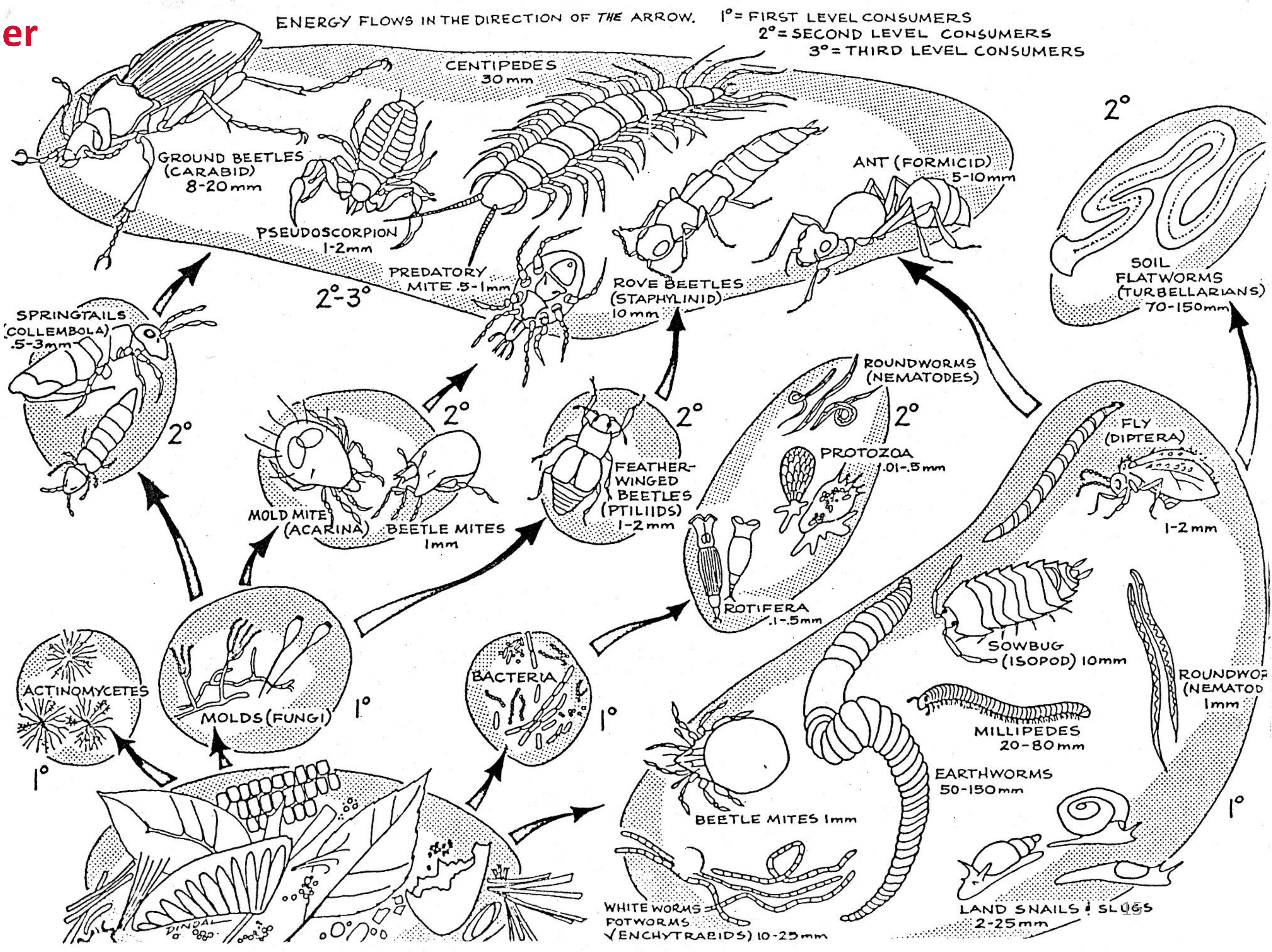


Soil Fertility OSU

Case Study A – the Trailer

How can we measure their activity?

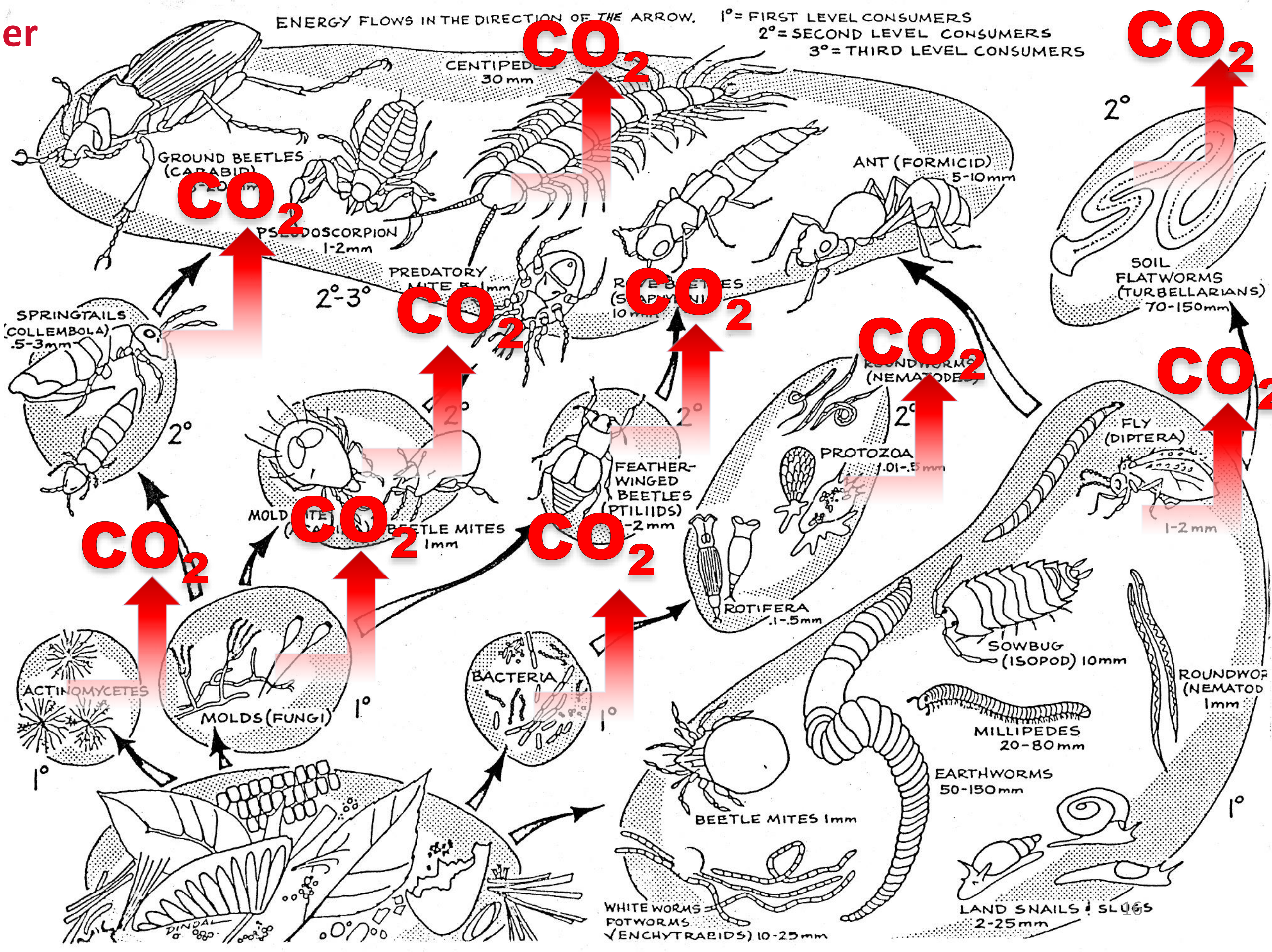
1. **Respiration (or breathing)**
2. **Decomposition**
3. **Abundance**



Case Study A – the Trailer

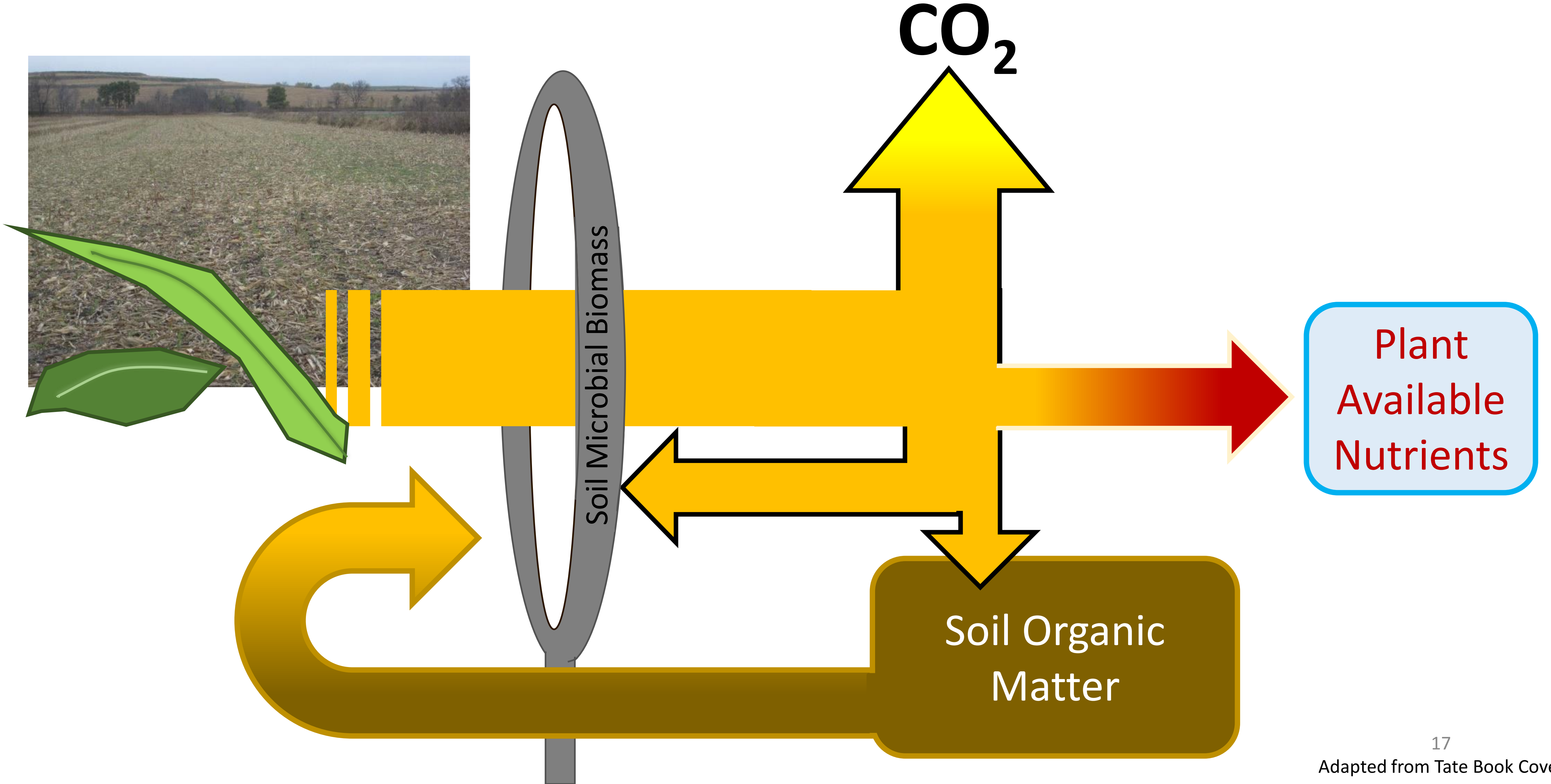
CO_2 Burst

1. <u>Respiration (or breathing)</u>
2. **Decomposition**
3. **Abundance**



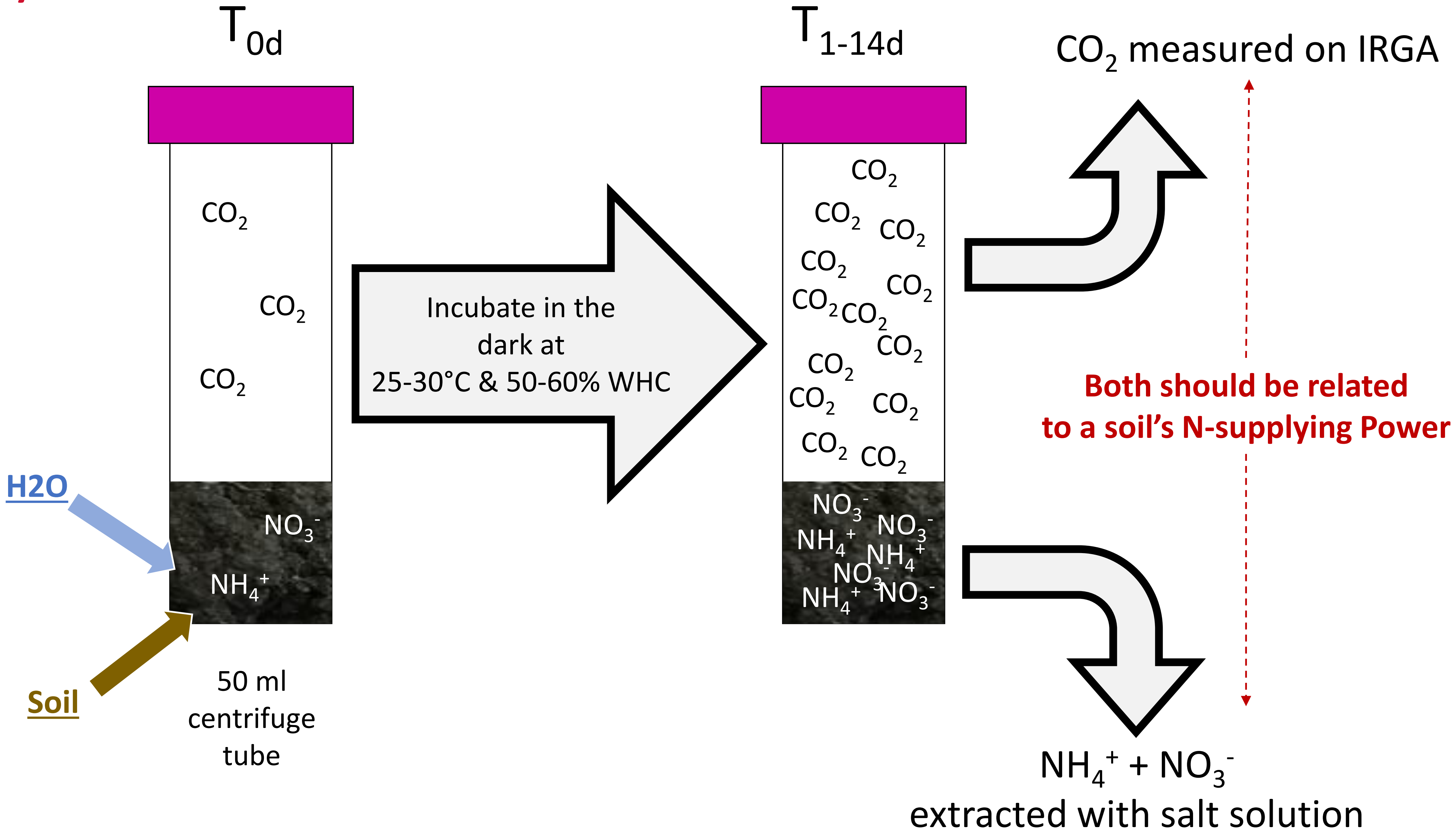
Case Study A – the Trailer

Microbial biomass – eye of the needle that all organic matter passes through



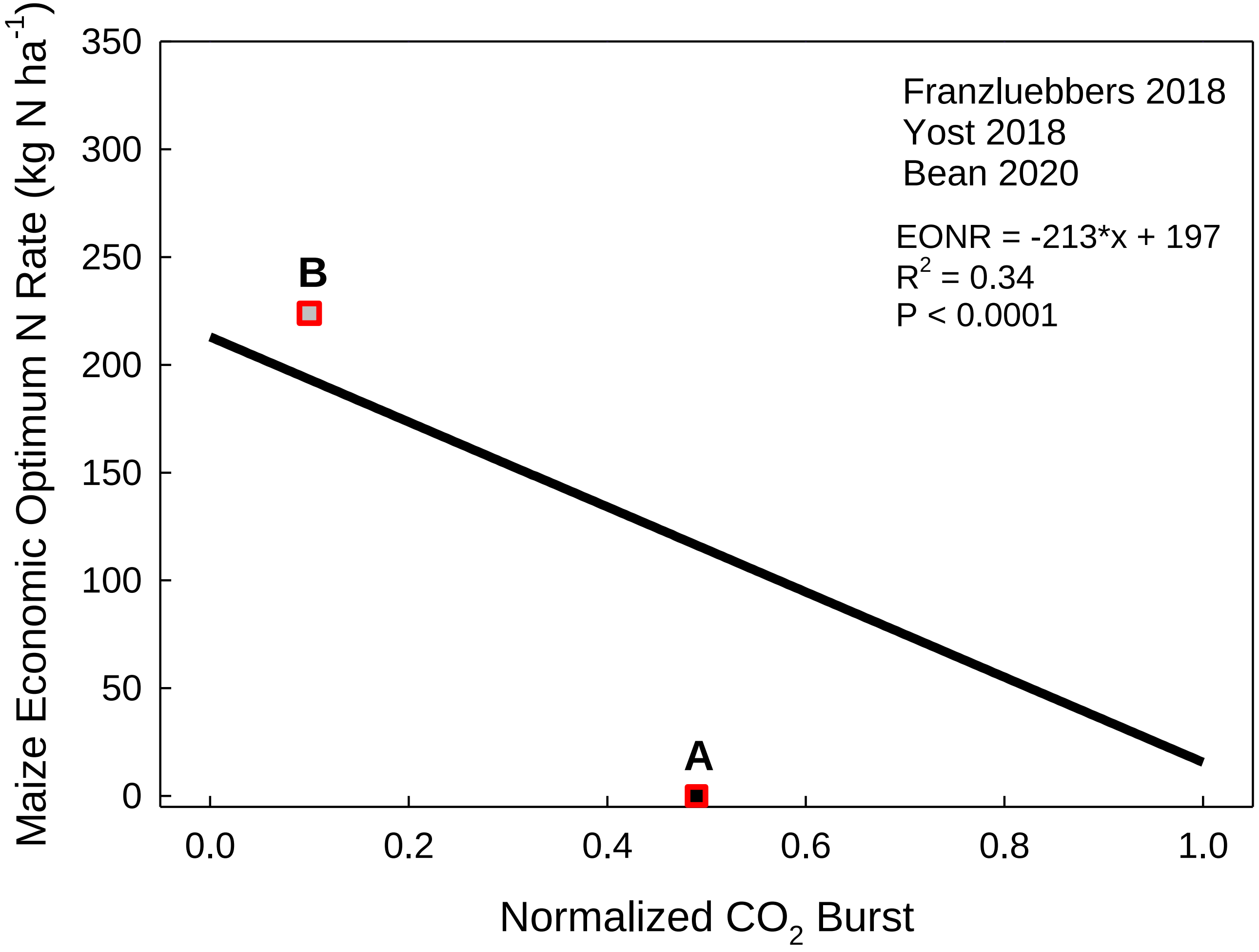
Adapted from Tate Book Cover

Case Study A – the Trailer



Case Study A – the Trailer

Greater soil biological activity = Less need for N fertilizer



Combined 3 recent studies that used "CO_2 Burst" test

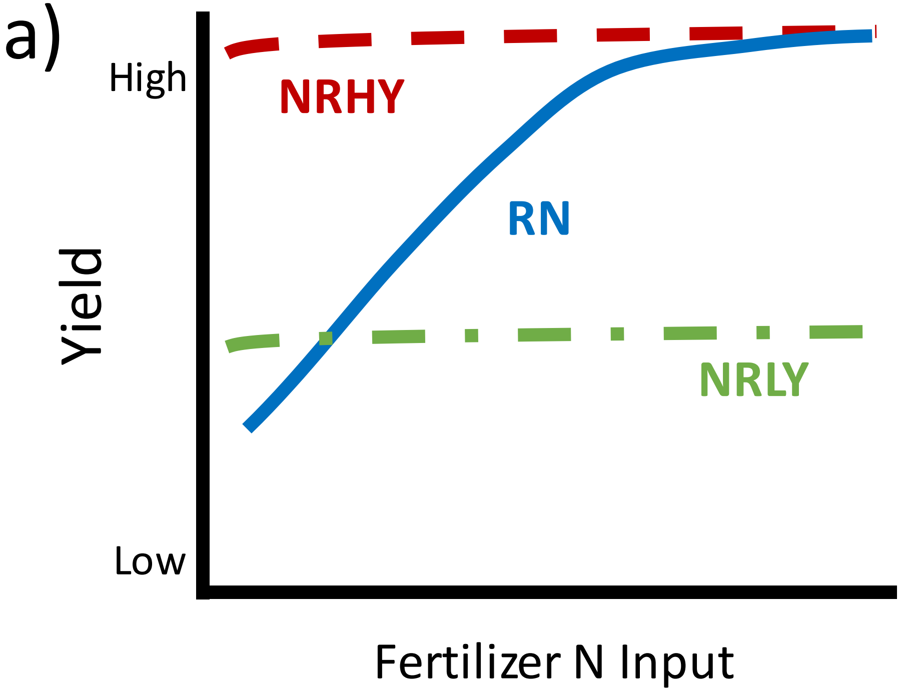
- 79 N-rate trials from Midwest used 1-day CO_2 Burst (Yost & Bean)
- 34 N-rate trials from NC and VA used 3-day CO_2 Burst (Franzluebbers)

Used maximum-minimum normalization to put on same x-axis

A lot of variability, but shows definite potential.

Franzluebbers et al. 2018, Yost et al. 2018, Bean et al. 2020

Probably need more than just "N supplying power" to accurately predict corn AONR



NRHY = **N**on-**R**esponsive to N and **H**igh **Y**ield

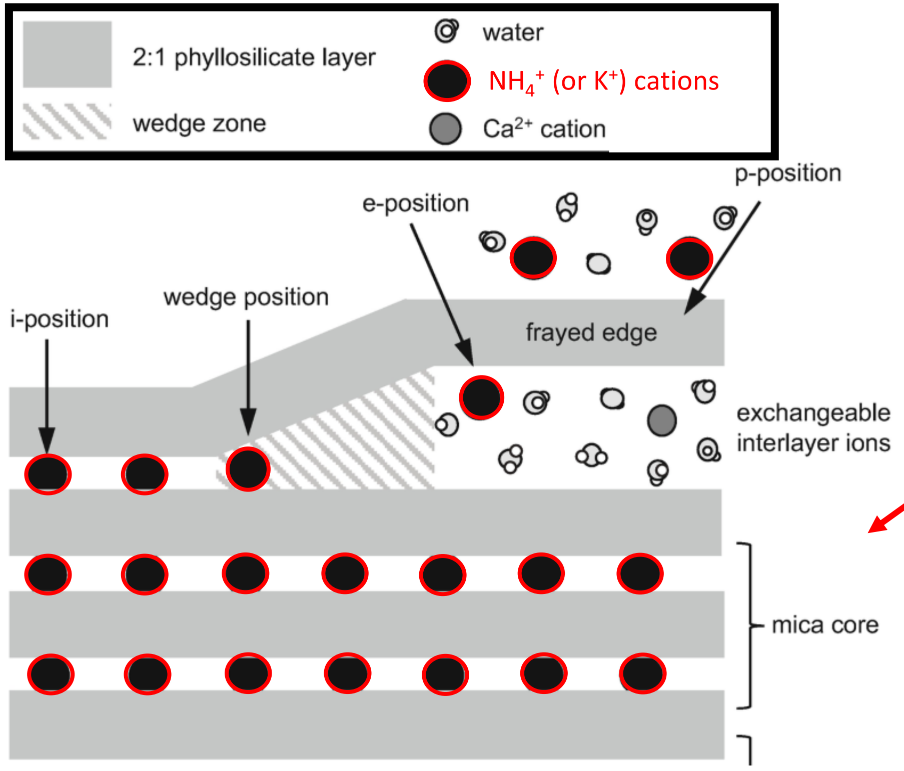
NRLY = **N**on-**R**esponsive to N and **L**ow **Y**ield

RN = **R**esponds to **N**

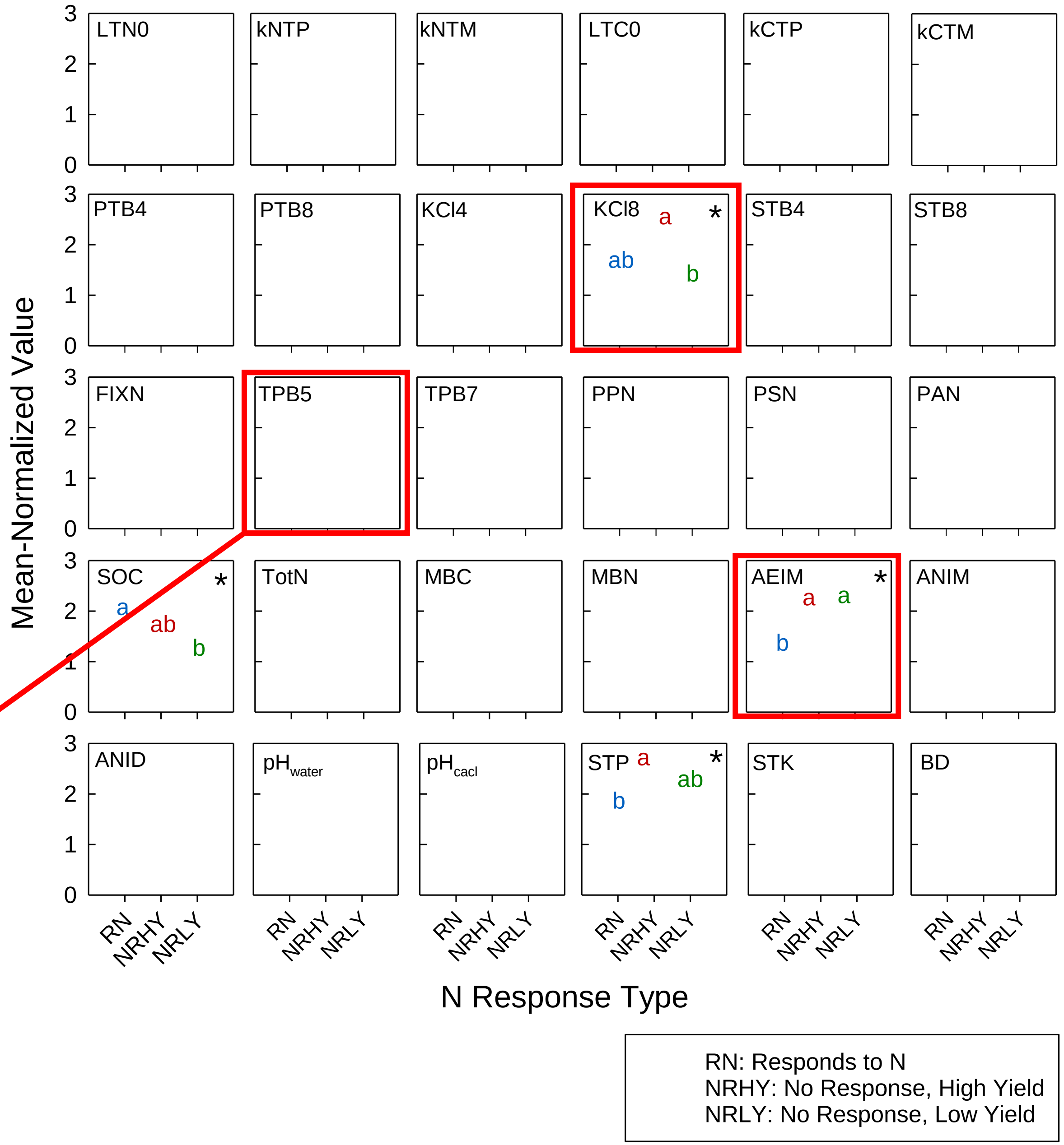
McDaniel et al. 2020_AJ

Case Study B – Trailer + Exclusive Cast Interview

- 56 site-years in Midwest
- Used >30 soil tests/measurements
- Had past management, climate, soil, and many other factors



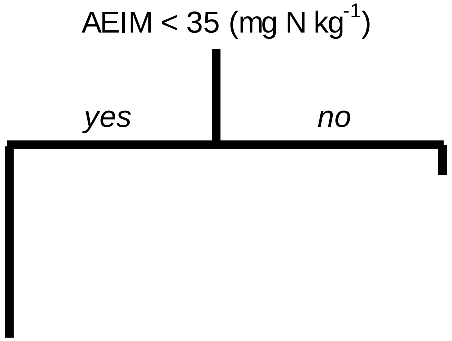
Bell et al. 2020_Chapter in *Improving K Recommendations For Ag Crops*

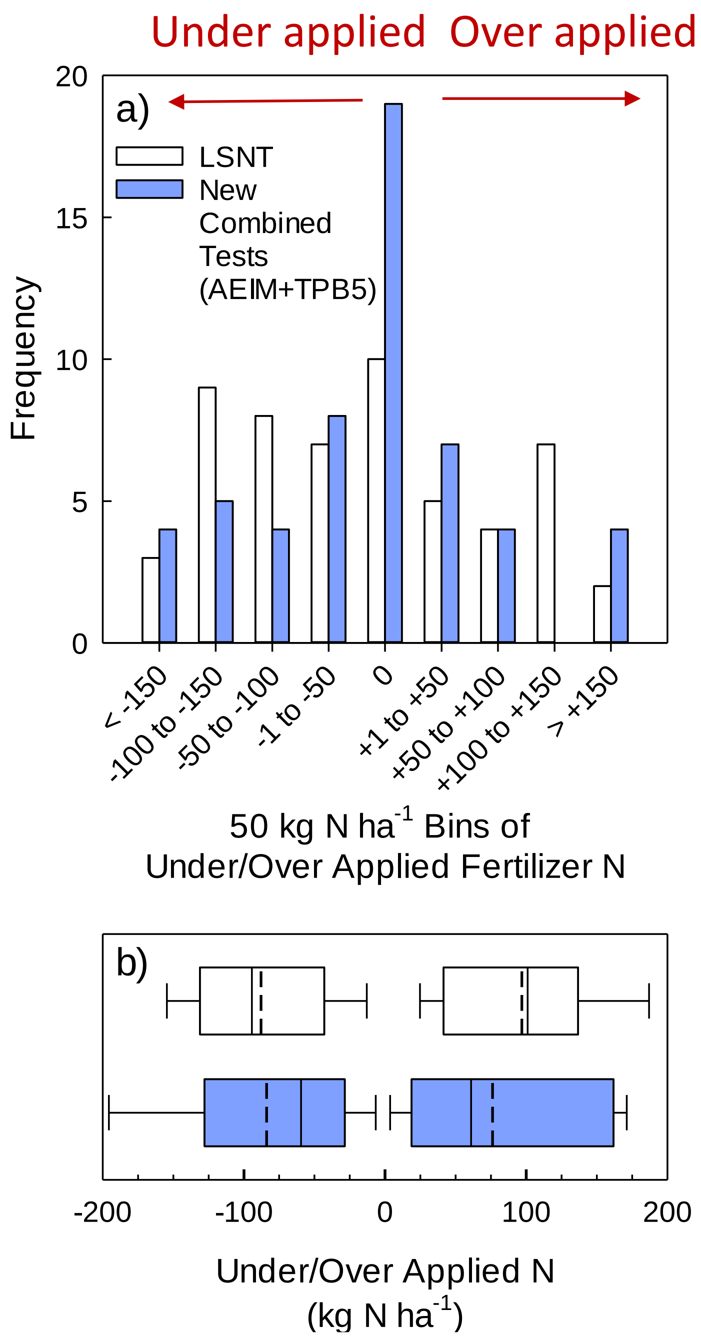


McDaniel et al. 2020_AJ

Case Study B – Trailer + Exclusive Cast Interview

A test (TPB5) that measures N stored between layers of micaceous mineral helps

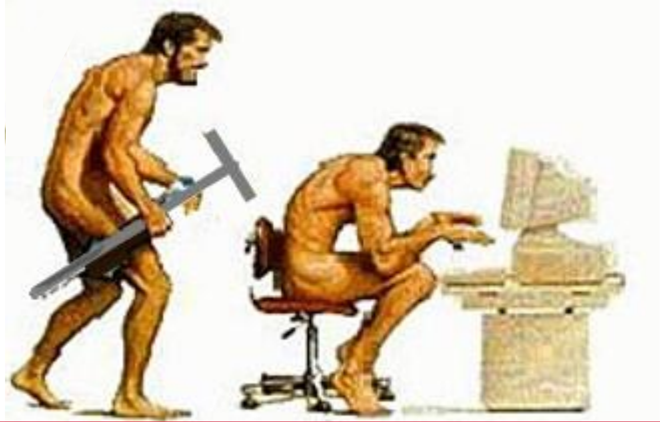




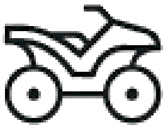
McDaniel et al. 2020_AJ

The Future of N Recommendations

(and role of soil sampling/analysis)



Remote/Proximal Sensors (Expand Spatial Prediction)

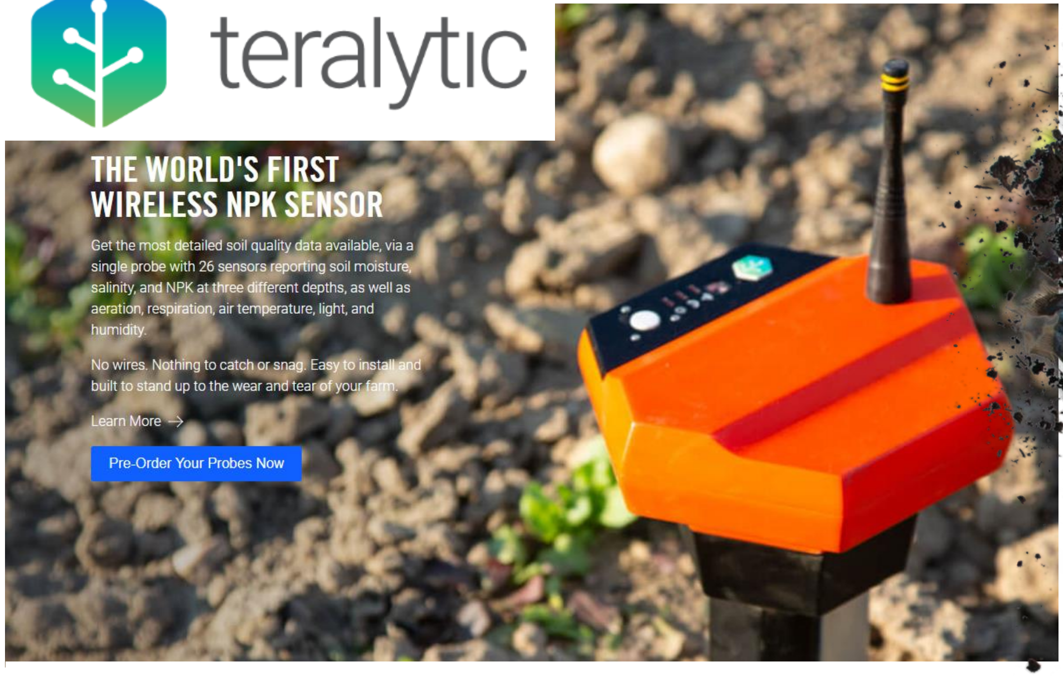
Sensor deployment platform	Coverage	Spatial resolution
	Global/National	Low
	Regional	Medium
	Local	High
	Site	Ultra high

Talbot et al. 2017

https://www.veristech.com/the-sensors

Soil Sensors (Expand Temporal Prediction)

teralytic



A DETAILED VIEW OF YOU FARM'S SOIL QUALITY

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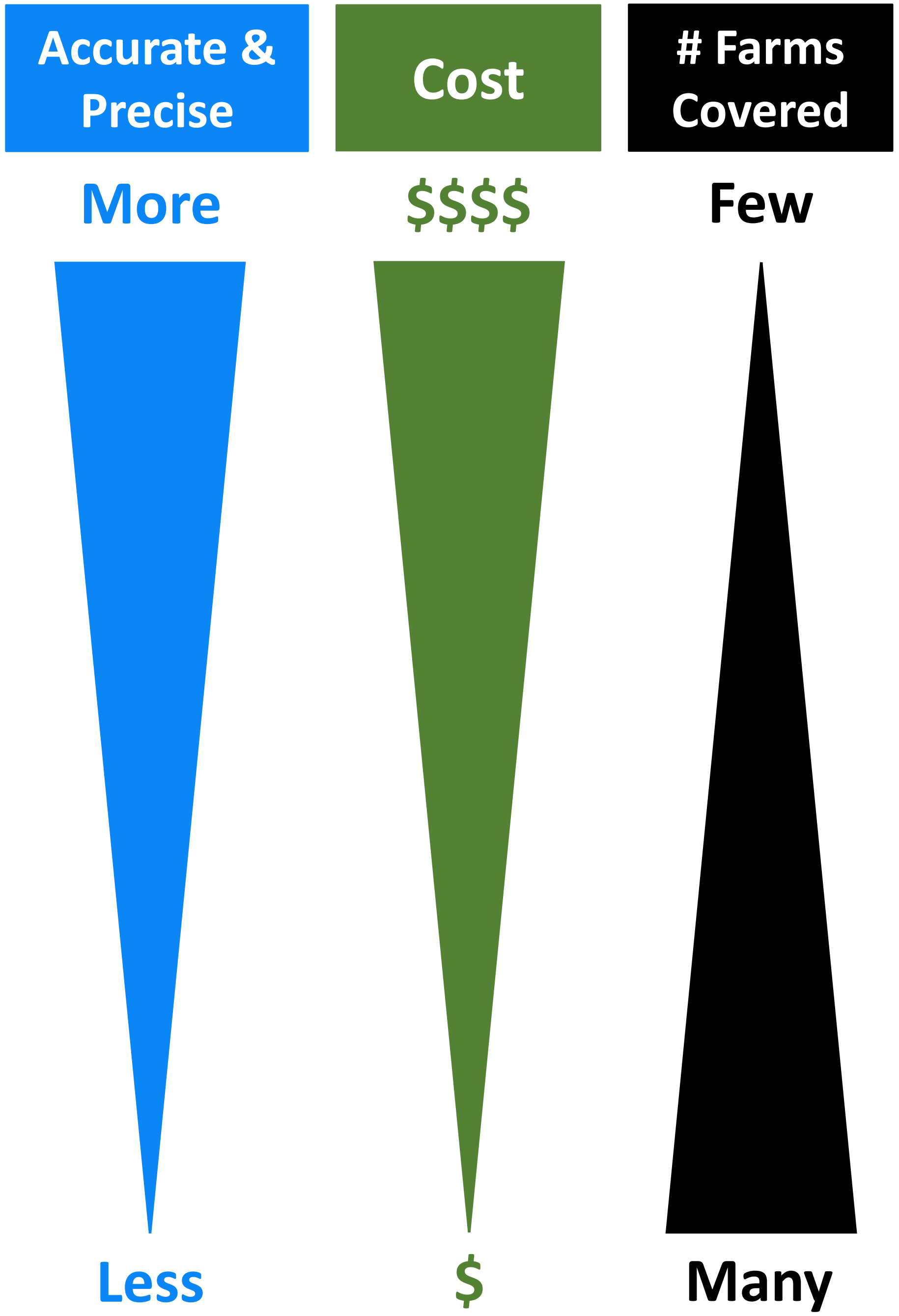
Microclimate SURFACE	Air Temperature Humidity Light
Soil Sensors 6IN, 18IN, 36IN DEPTHS (15CM, 45CM, 91CM)	Soil Moisture Salinity Soil Temperature pH Nitrate Potassium Phosphorus
Gas Sensors 18IN / 6IN DEPTHS (45CM / 15CM)	Aeration (O_2) Respiration (CO_2)

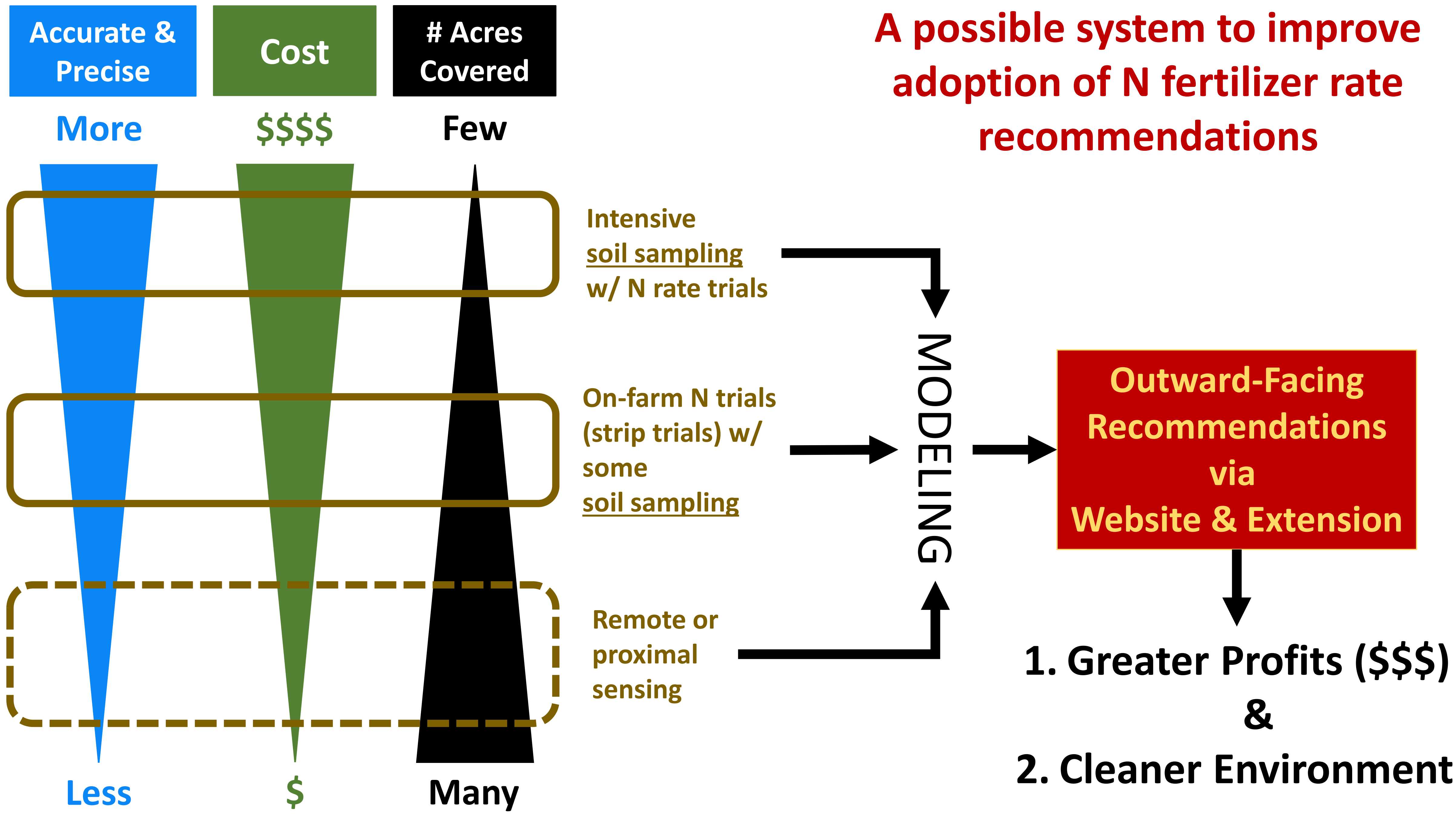
Trade-offs in technology require a nuanced approach

farm operators are not using current recommendation methods

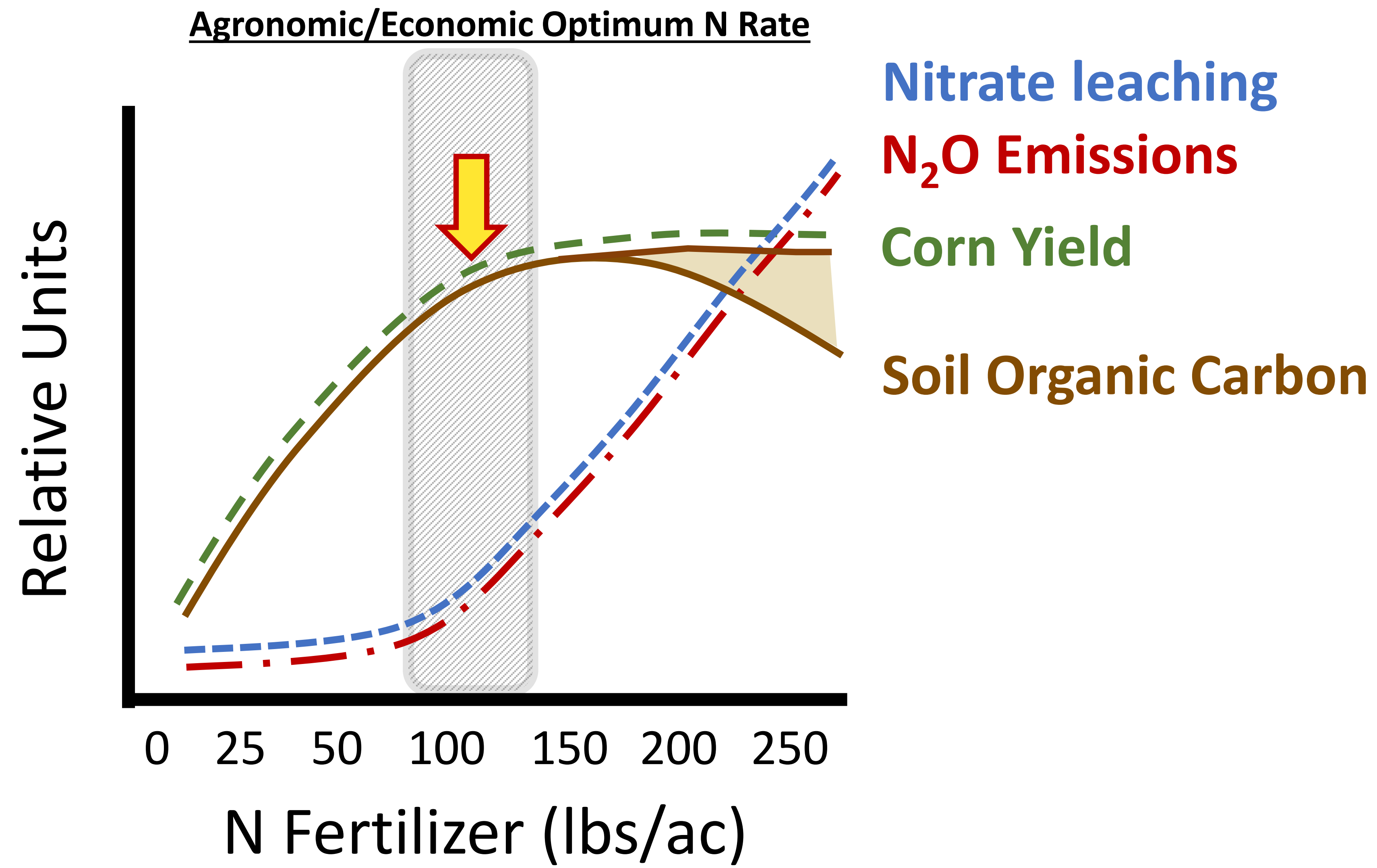
We need…

1. multi-tiered, multi-method approach to increase accuracy/precision AND **adoption** of N recommendations
2. some selected soil sampling/analyses still needed; esp. use novel approaches that measure N-supplying power!
3. Sensing, modeling, and multivariate/spatial statistics to extrapolate beyond intensively measured fields
4. user-friendly website for farm operators
5. strong Extension programs




A possible system to improve adoption of N fertilizer rate recommendations
Accurate & Precise
Cost
Acres Covered
More
$$$$
Few
Less
$
Many
Intensive soil sampling w/ N rate trials
On-farm N trials (strip trials) w/ some soil sampling
Remote or proximal sensing
MODELING
Outward-Facing Recommendations via Website & Extension
1. Greater Profits ($$$)
&
2. Cleaner Environment

Predicting crop N needs has never been more important!

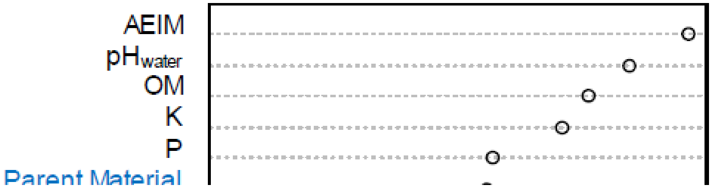


Questions?

Email: marsh@iastate.edu
: @Soil_Plant_IXNS

Case Study B

Having management, climate, and other variables didn't help out all that much



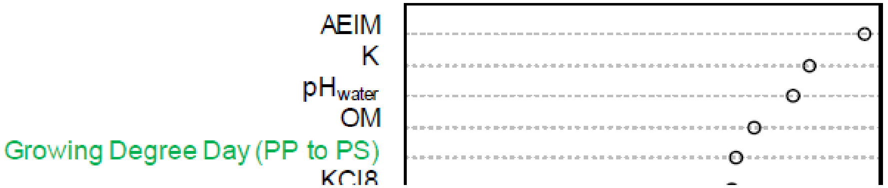
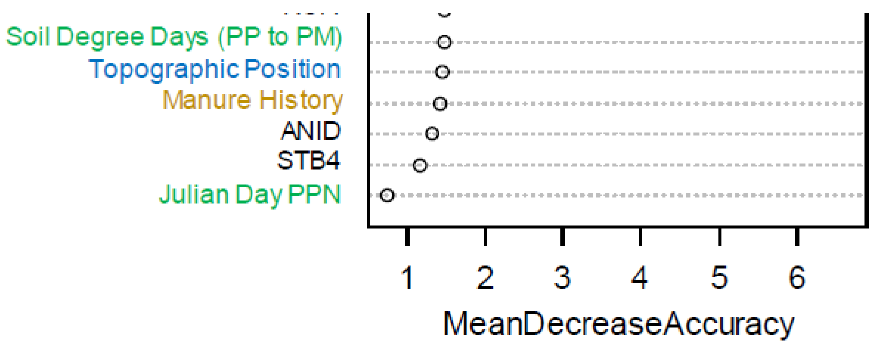
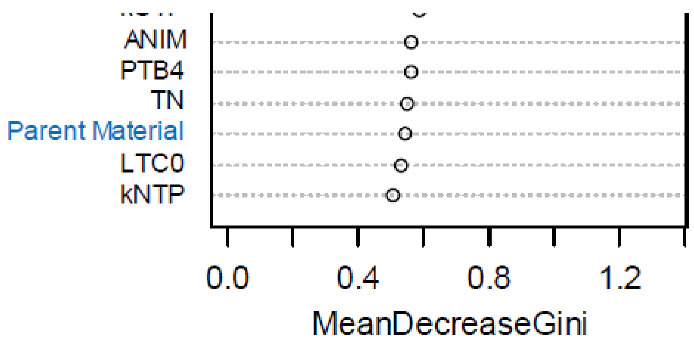


TABLE 5 Comparison between number of observed and predicted site-years that responded to N fertilizer from two methods: management, soils, and climate model (no-soil-test-required) and 14-d aerobic incubation (AEIM) soil test

	Management, soils, and weather model			AEIM		
	Predicted (n)			Predicted (n)		
Observed	No response	Response	Accuracy	No response	Response	Accuracy
No response	15	8	65%	17	7	71%
Response	5	27	84%	6	26	81%
Total % accuracy			82%			77%





McDaniel et al. 2020_AJ