Overview of Methodologies to Improve Sustainability Through Nutrient Use Efficiency

2010 FERTILIZER AND TECHNOLOGY CONFERENCE

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Traditional Nitrogen Response Studies

Fundamental Principle of Agronomy

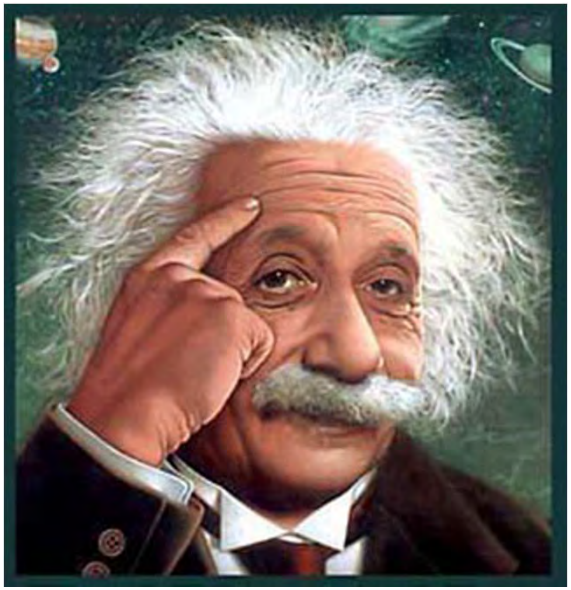
There is NO such thing as MAGIC

Math, Chemistry, Physics, Physiology…

$$e=mc^2$$

$e=mc^2$ Boundary Condition

Maximum amount of energy that can be extracted from an object



What is the boundary condition for fertilizer use efficiency?

Traditional N Boundary Condition

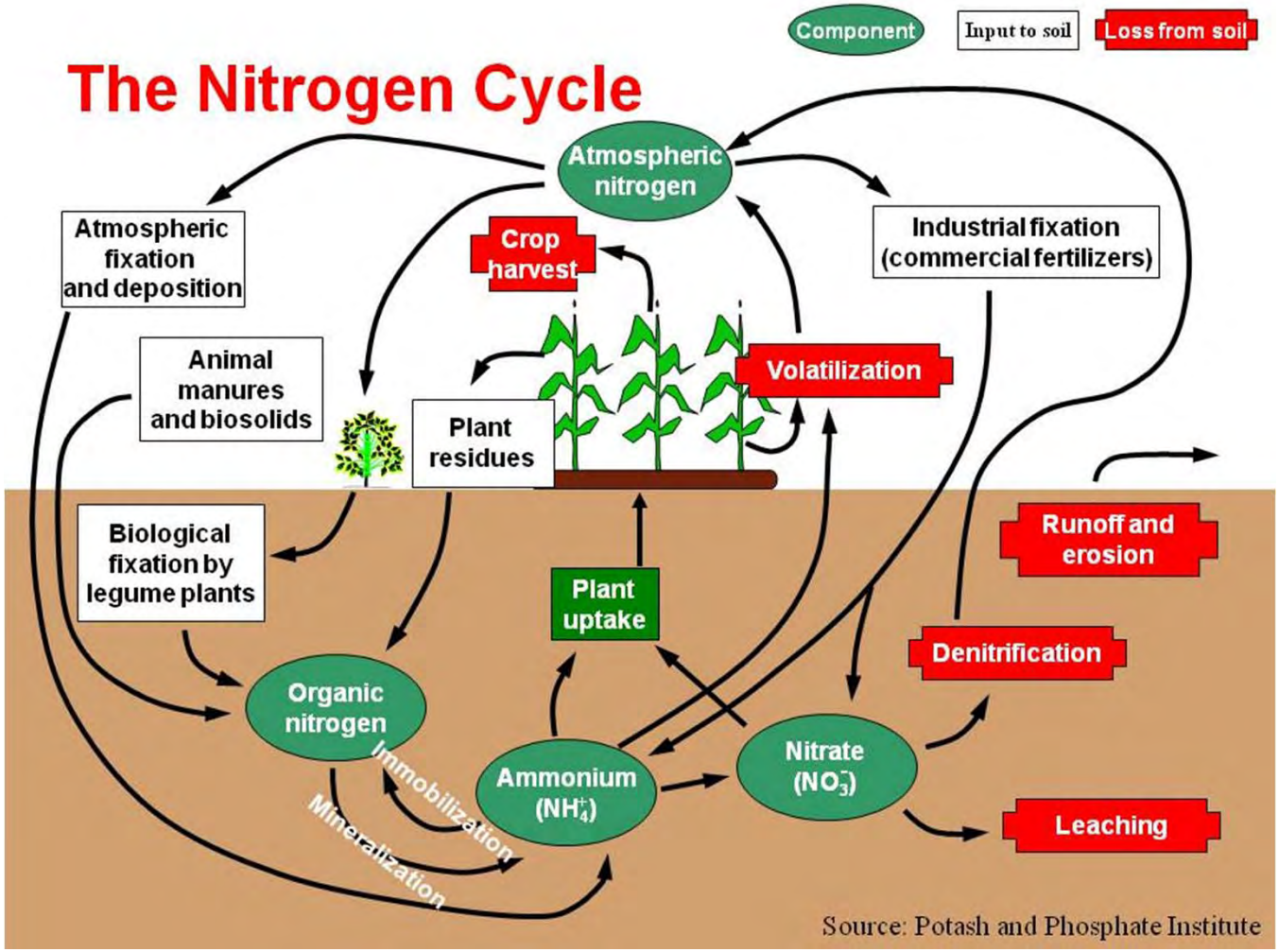
Example:

Treatment lb N/acre	Grain N Removed lb	NUE %
0	50	
100	110	
150	130	

Worldwide, nitrogen use efficiency for cereal production (wheat, corn, rice, barley, sorghum, millet, oats, and rye) is approximately 33%.

(Raun and Johnson, 1999)

Nitrogen Boundary Condition



Ecological N Efficiency

Boundary Condition

Monoculture Corn – No N Loss

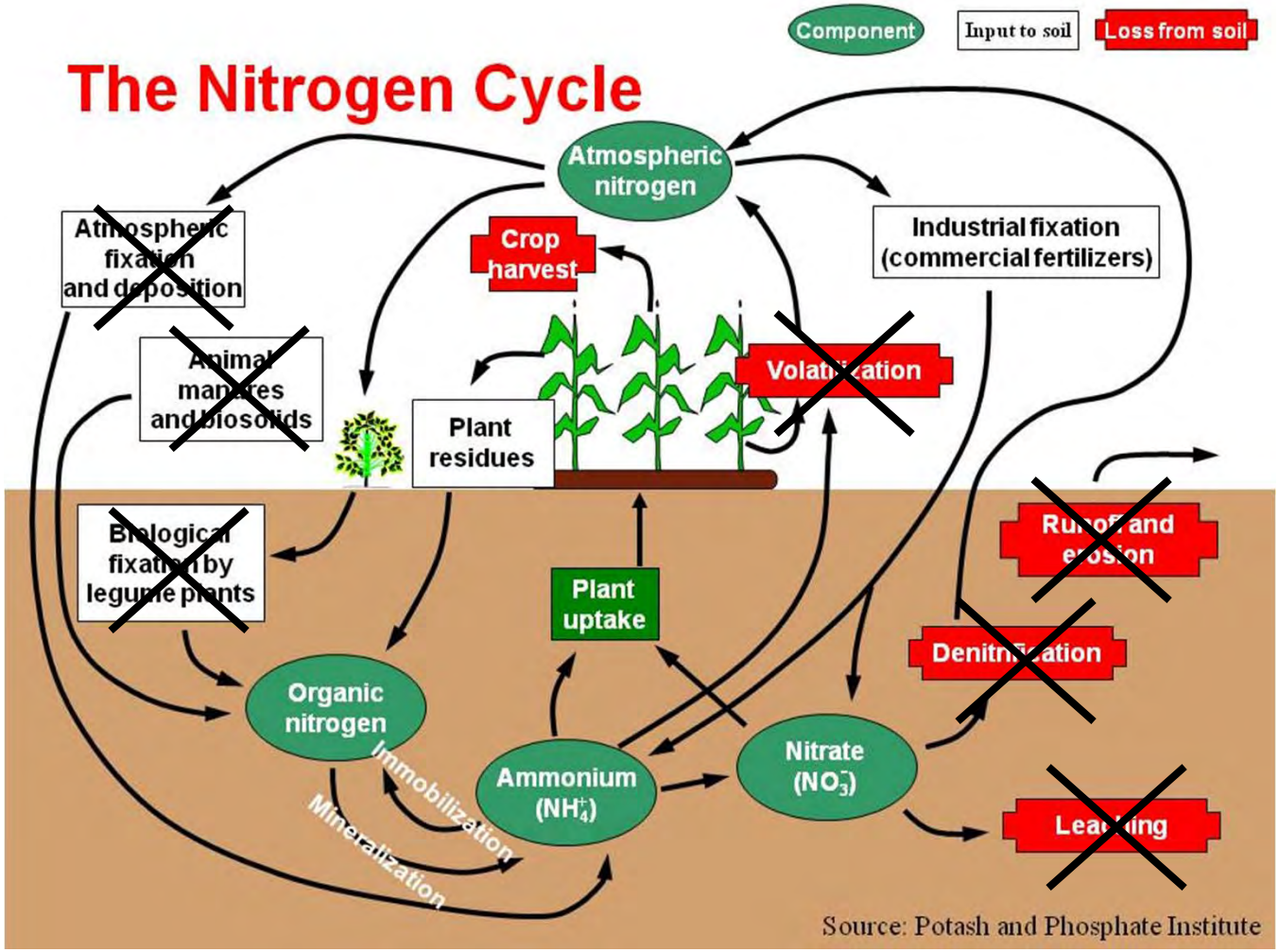
N Applied = N removed

Real World Condition

N Applied + Other Sources =

N Removed + N Lost

Monoculture Corn – No N Loss



Nitrogen Boundary Condition

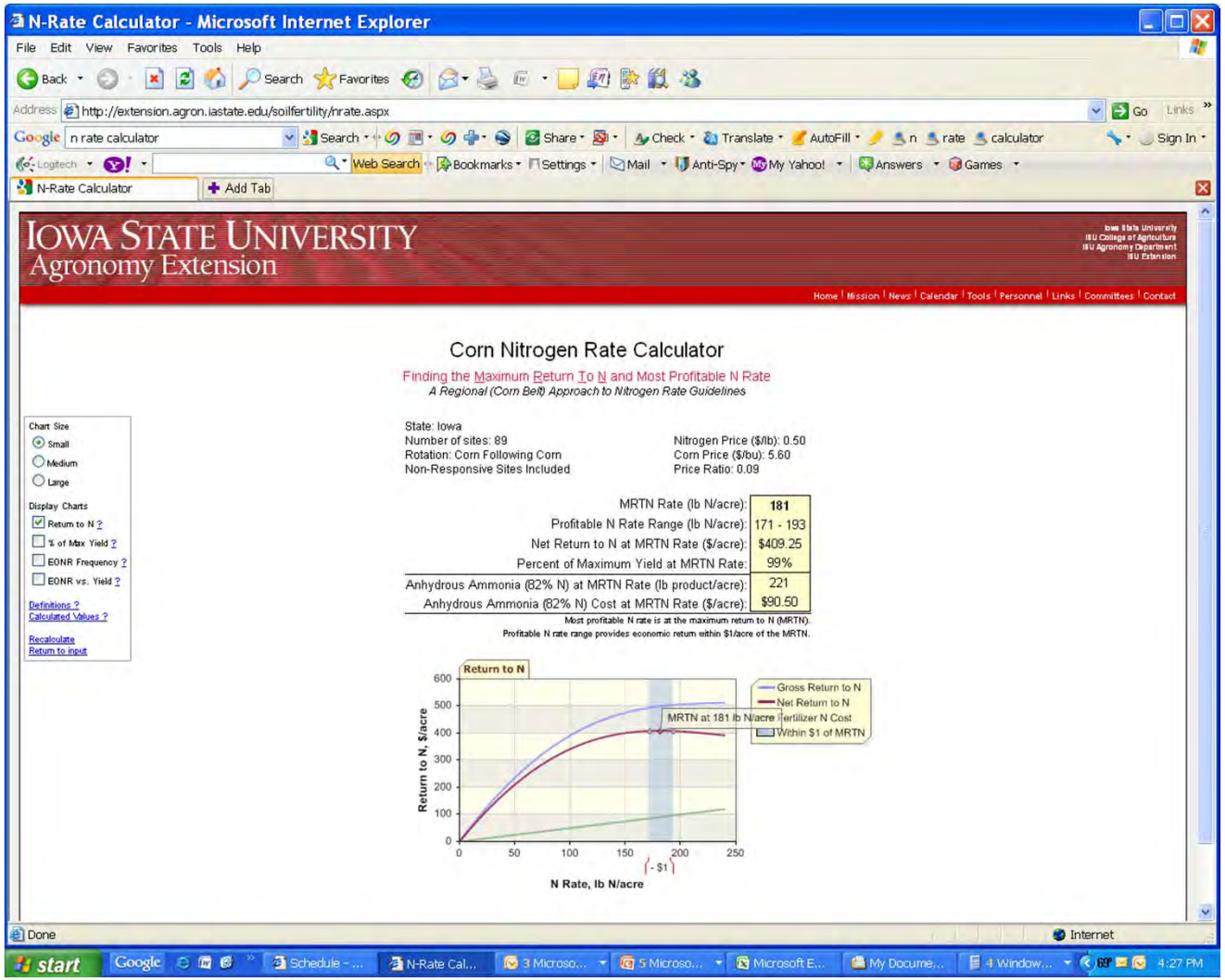
Monoculture Corn – No N Loss

Treatment lb N/acre	Grain N Removed lb	NUE %	ENE lb
0	50		**-50**
100	110	60	**-10**
150	130	53	**+20**

ENE – Ecological Nitrogen Efficiency

Title: Methodologies to Improve Sustainability Through Nutrient Use Efficiency

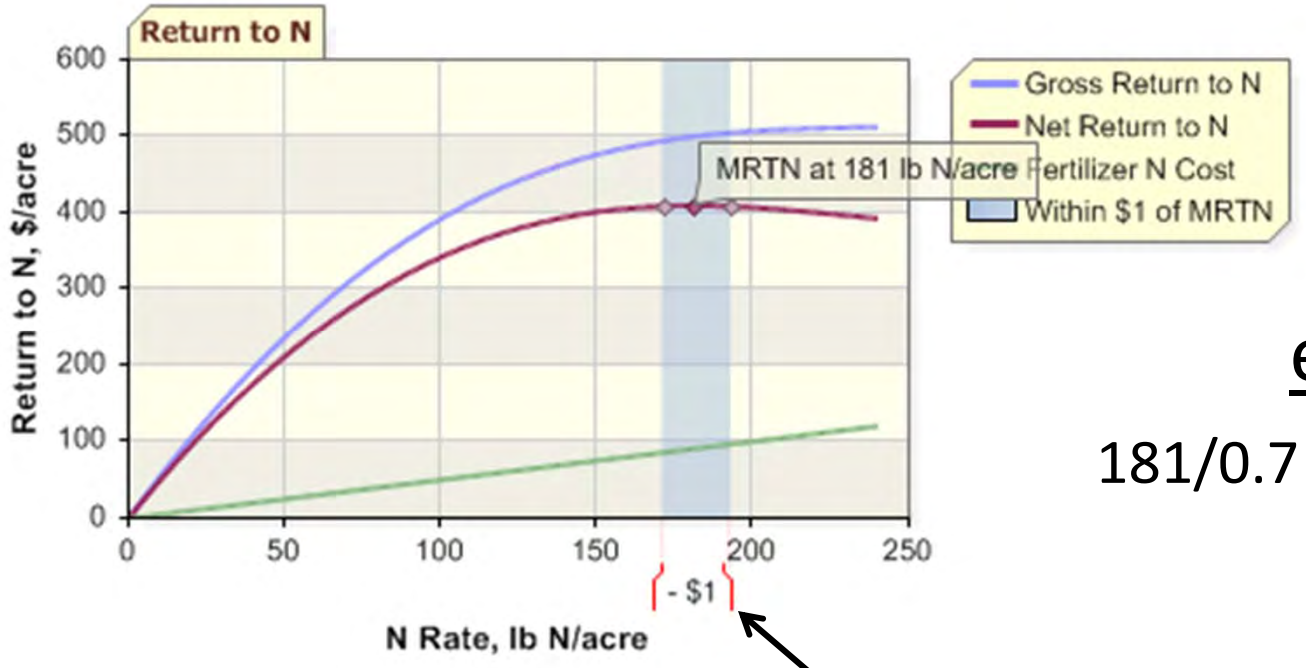
How Close Are We to $e=mc^2$



How Close Are We to $e=mc^2$ in Iowa

MRTN – Maximum Return to Nitrogen

Corn Nitrogen Removal = 0.7 lb per bushel



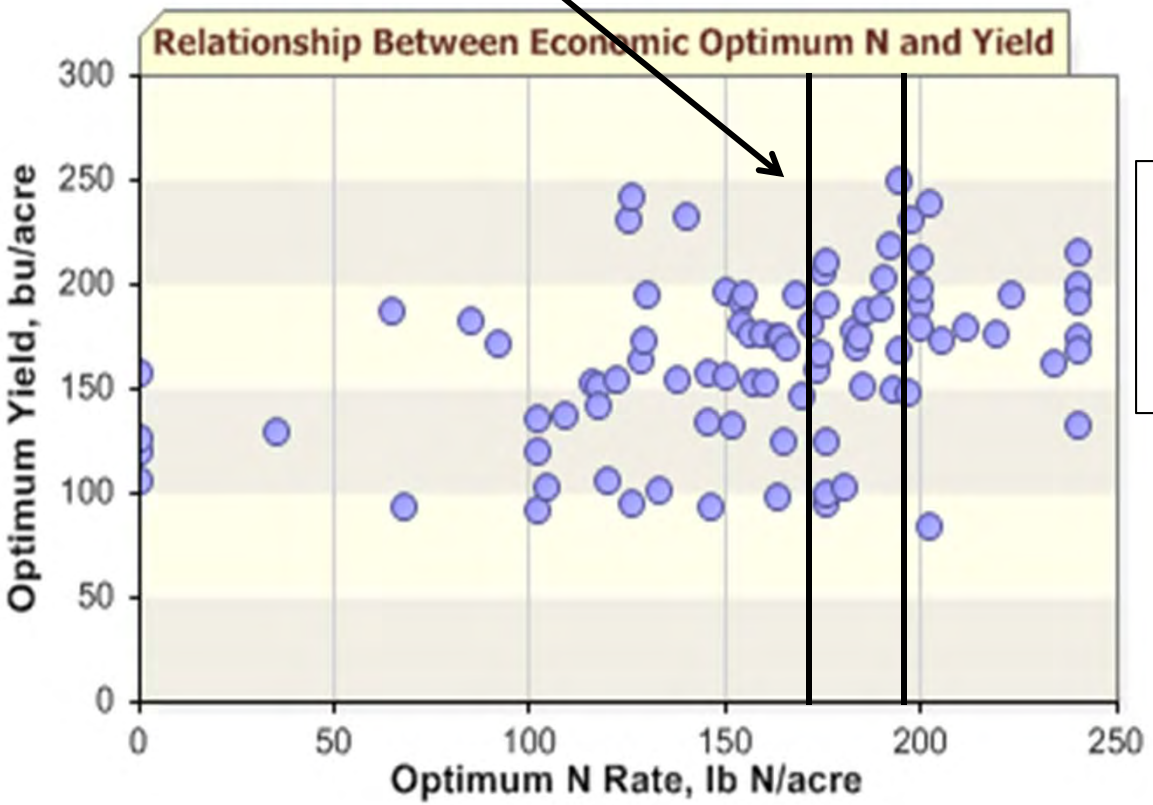
Profitable range 171-190

$e=mc^2$

181/0.7 = **259** bushels

MRTN – Maximum Return to Nitrogen

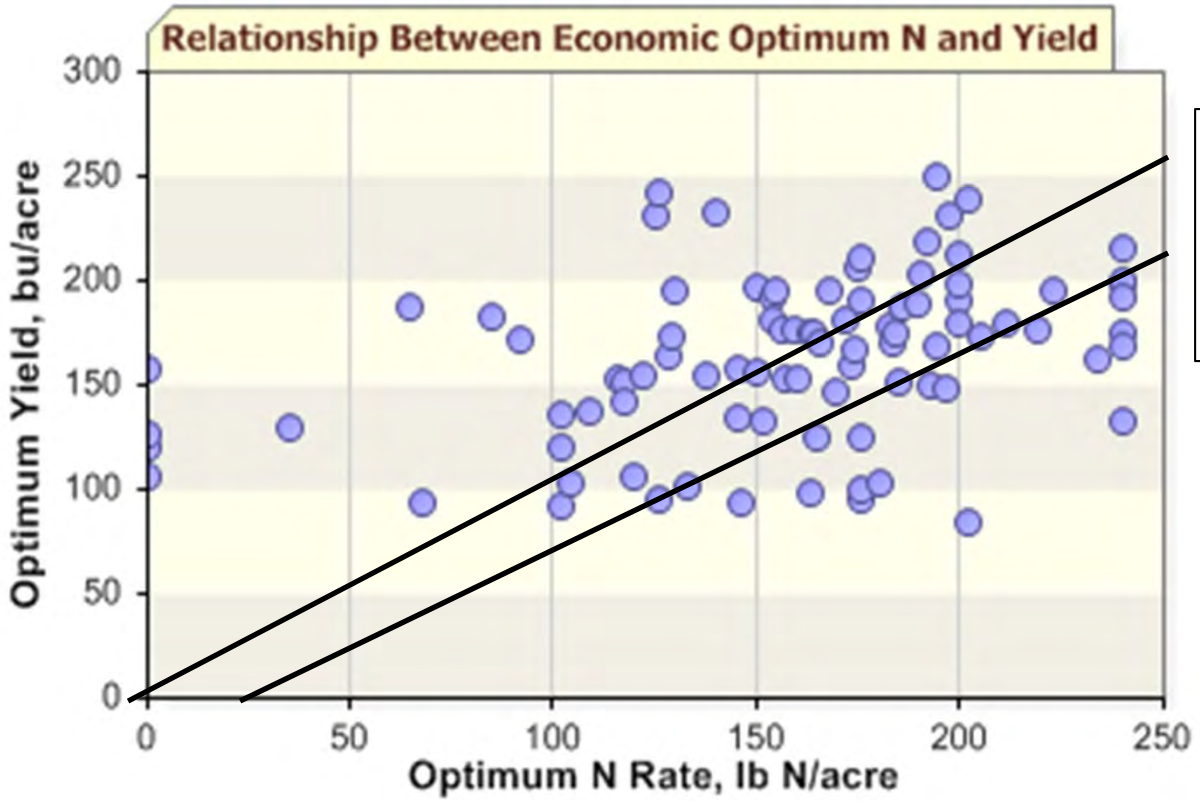
Recommended range 171-190
Using MRTN



21 Sites Within Range

Yield Goal Approach

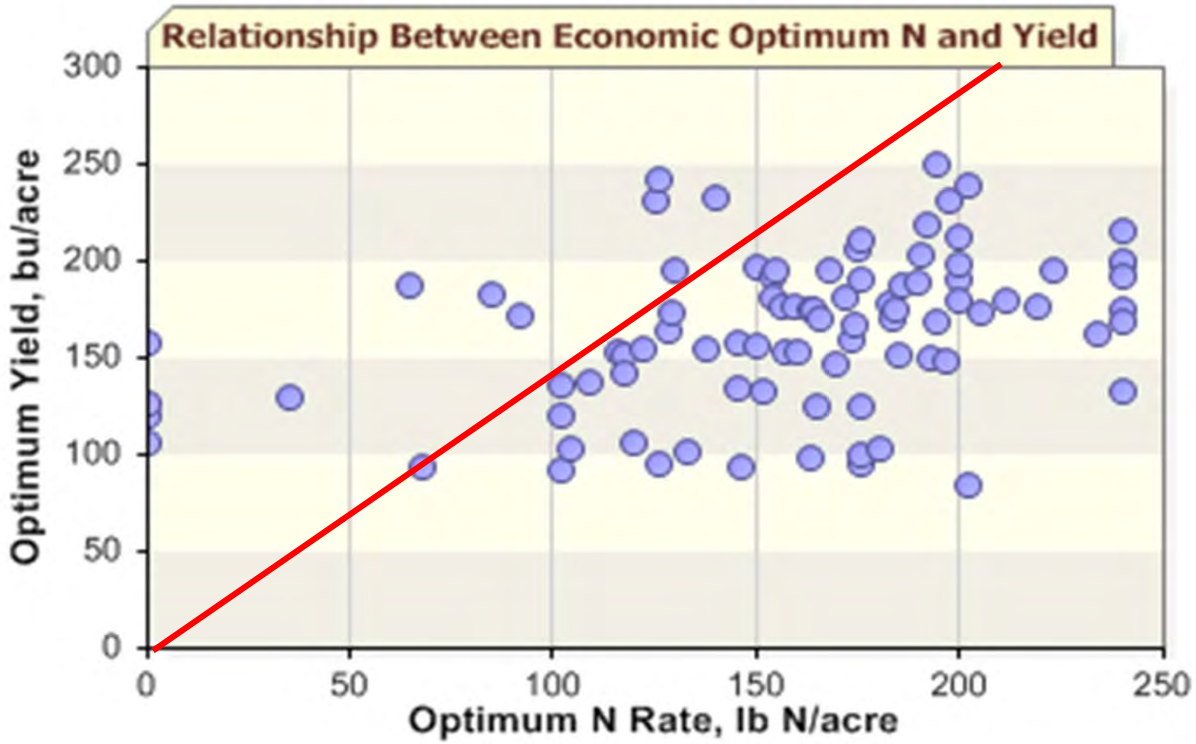
Recommended range using
1.2 x Yield ± 19 lbs N/acre



28 Sites Within Range

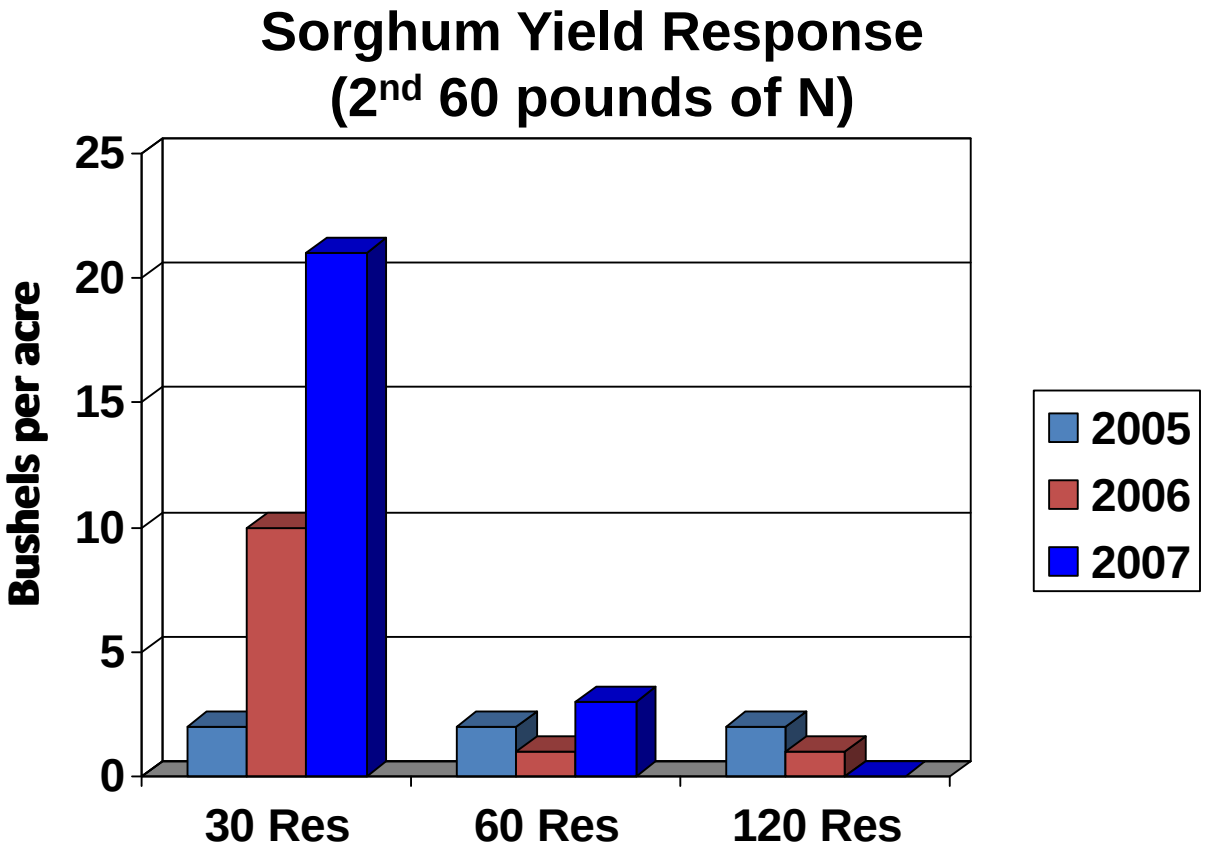
Ideal vs. Real-world

Maximum Possible 0.7 x yield



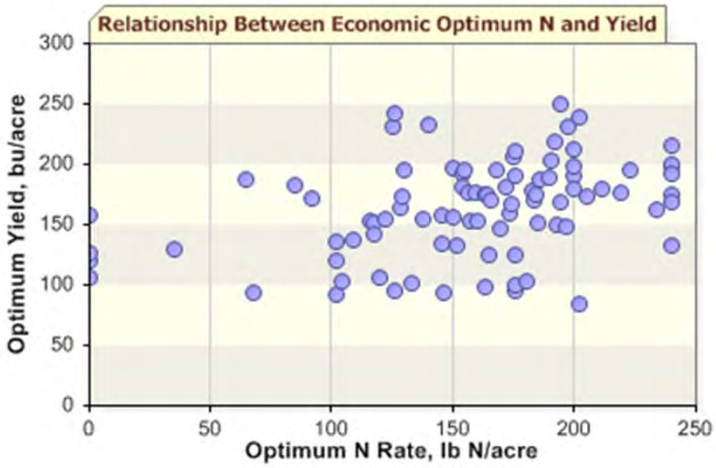
Why is there so much scatter?

Past Management Makes a Difference



(Mengel et al., 2007)

Lessons from the N Rate Calculator
(According to Schwab)



The EONR method **DOES NOT** improve ecological efficiency or sustainability

Improvements are possible if you understand the scatter

Environment	**Losses**
Past N Mgt	Volatilization
Precipitation	Immobilization
Placement	Denitrification
Drainage	Leaching

Genetics??

BT-Rootworm is… NOT USEFULL….

Unless nitrogen is captured that would have otherwise been lost

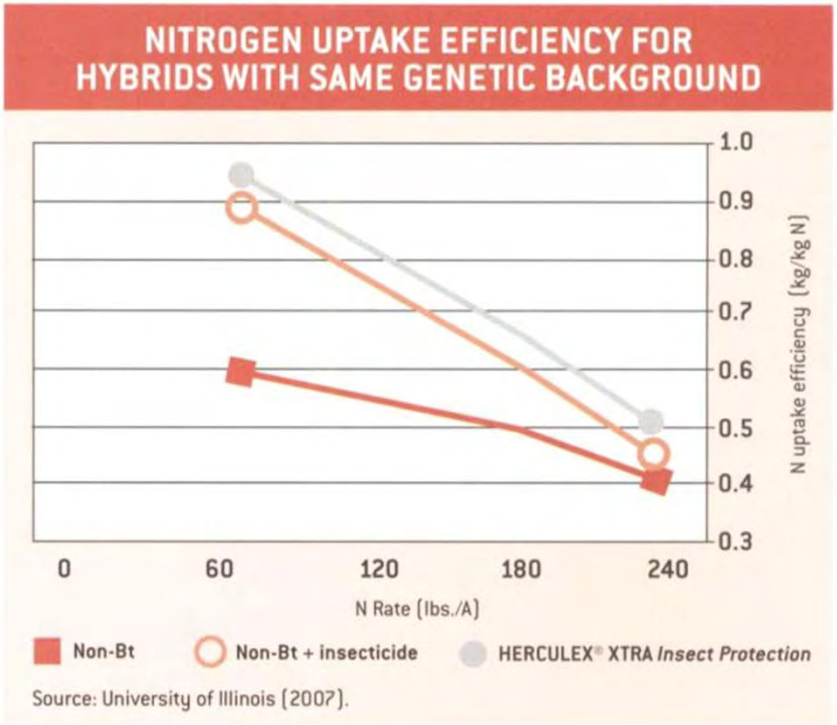


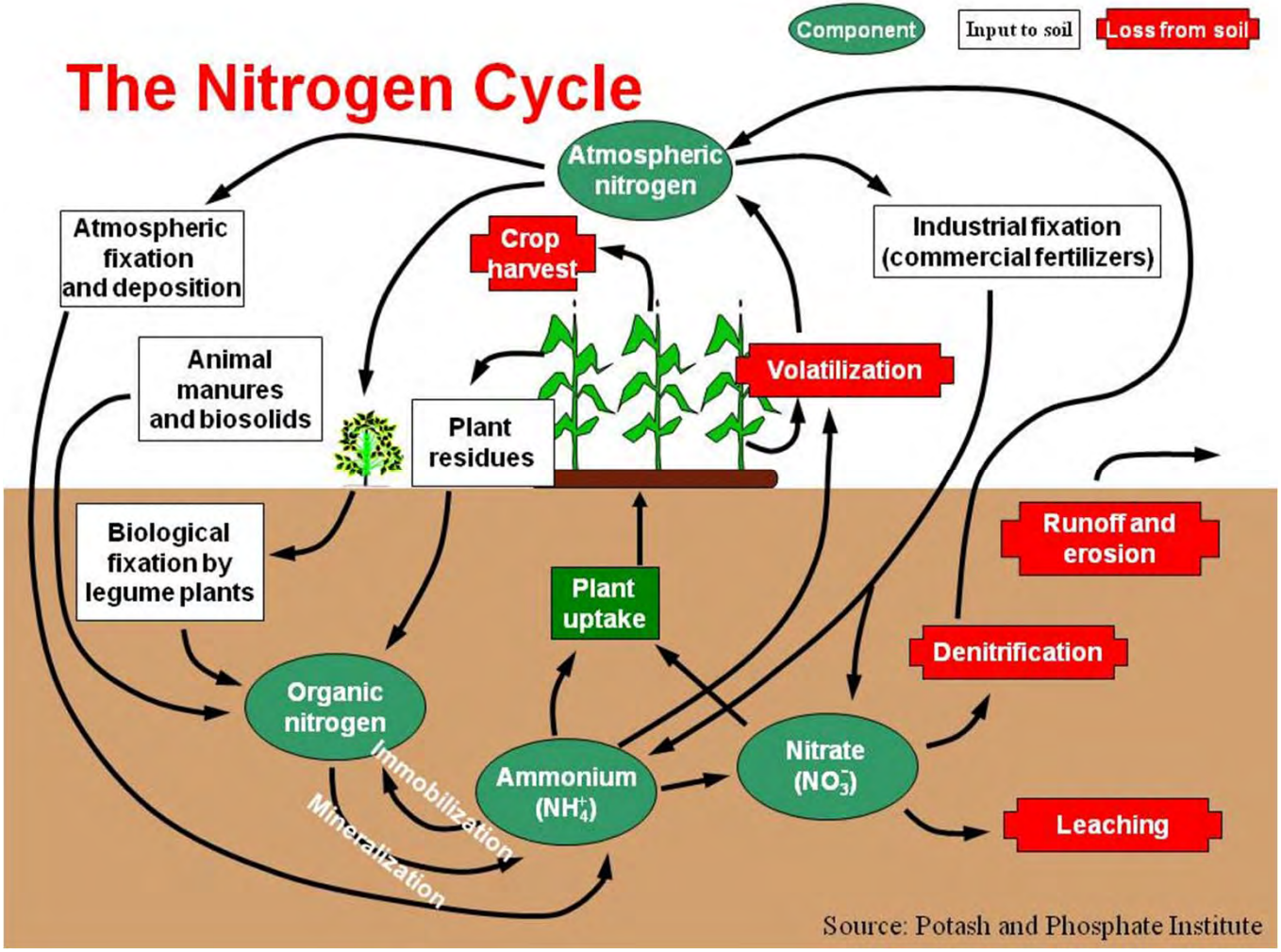
Image Taken from 2011 Seed Guide

Genetics could be used to

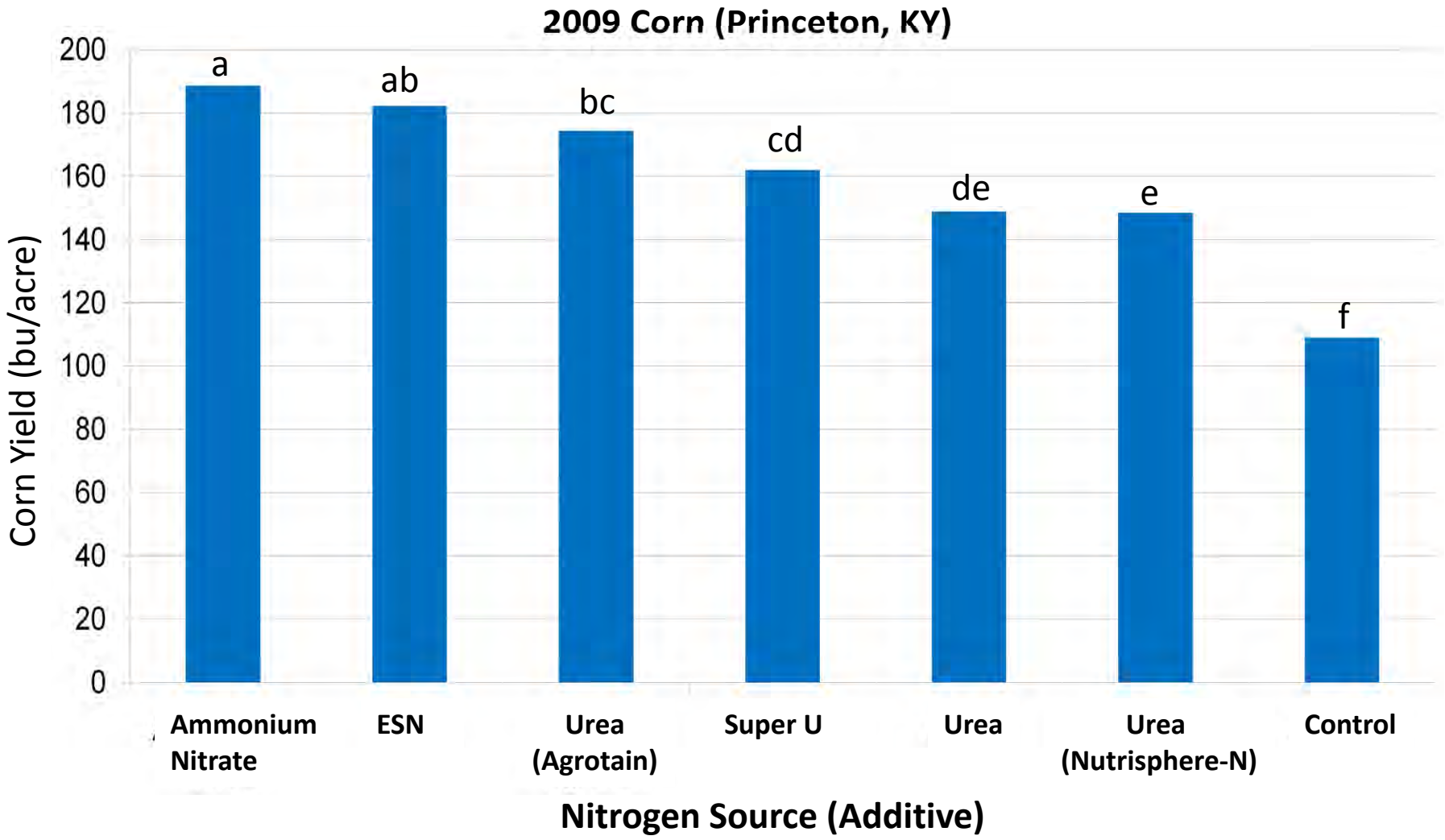
Reduce nitrogen in the grain (reduce protein)

Engineer corn to 'fix' nitrogen (but this also has a cost)

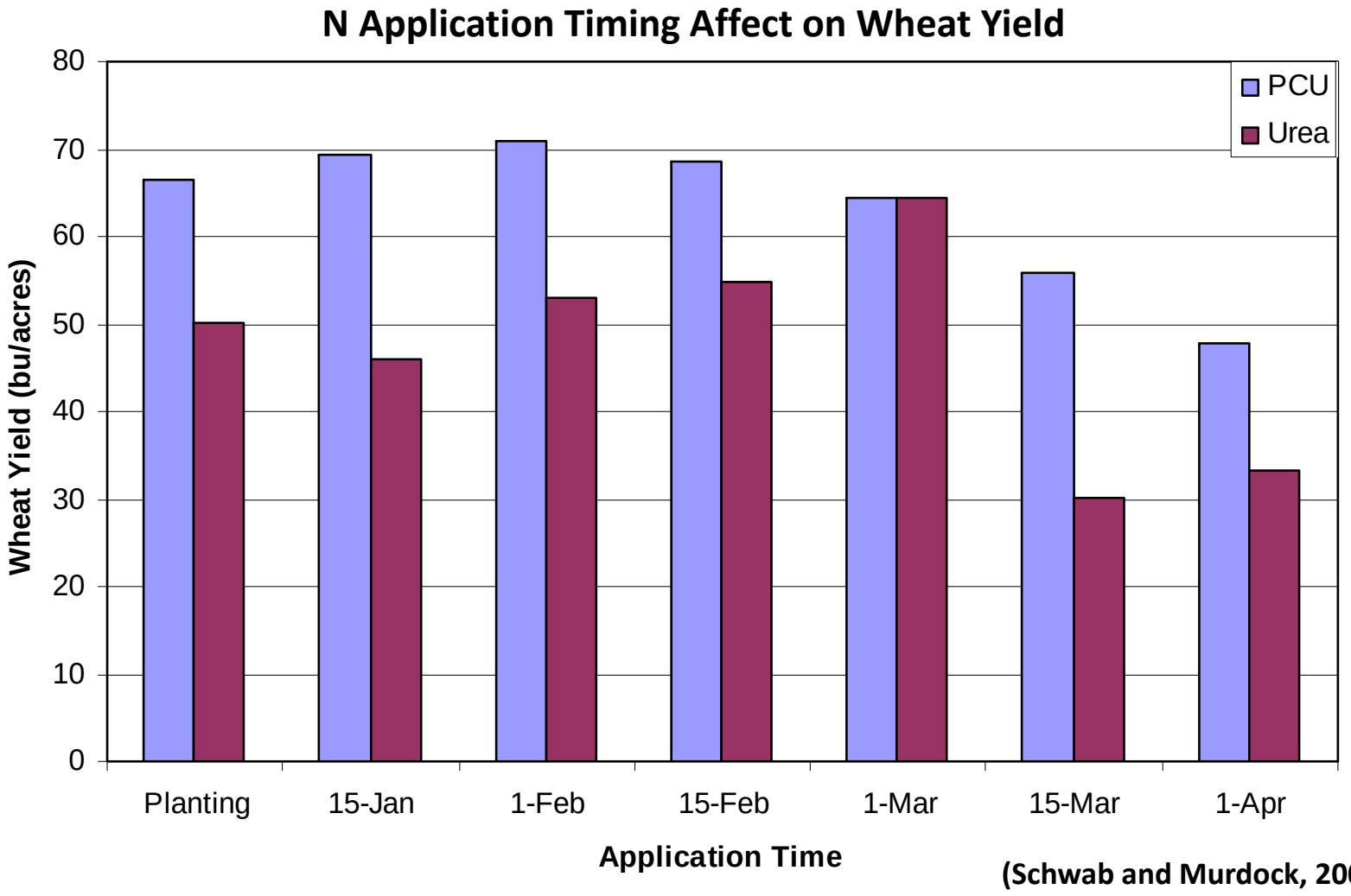
Key – Control Nitrogen Loss



Fertilizer Technologies – Nitrogen Stabilizers



Fertilizer Technologies – Coatings



(Schwab and Murdock, 2006)

Precision Agriculture

Spatial Estimation

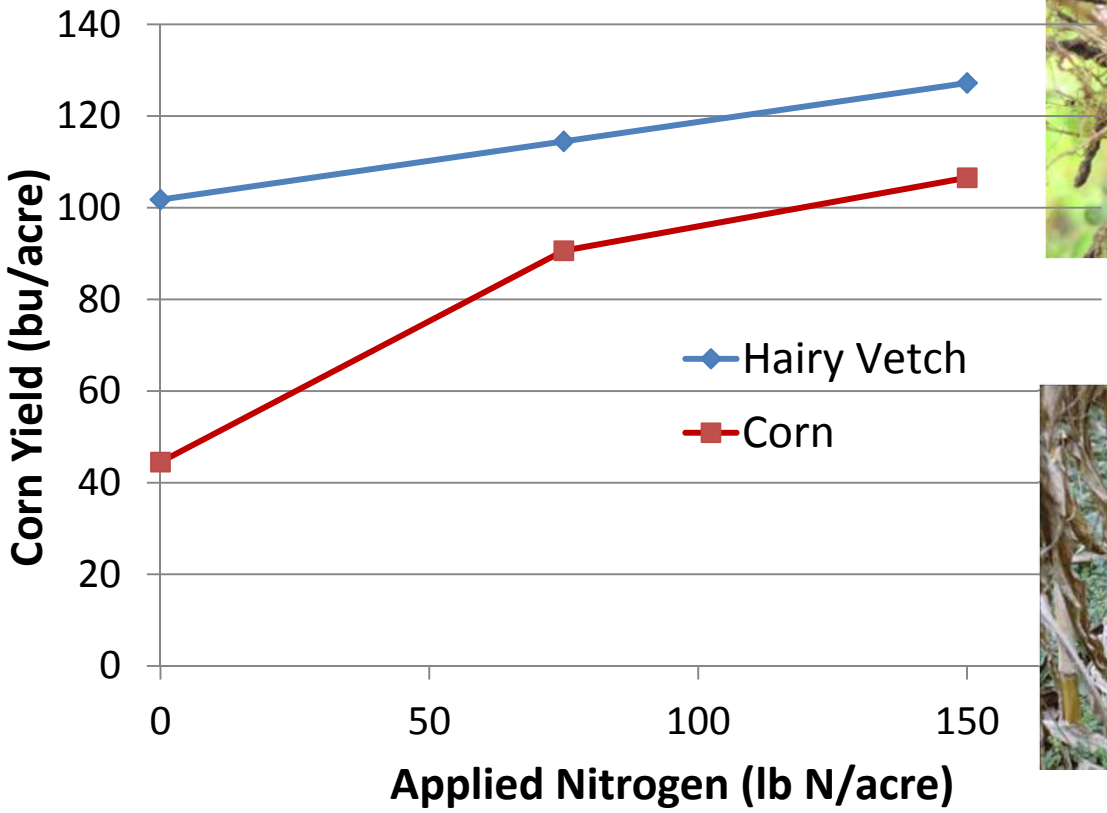
Nitrogen Loss

Yield Potential

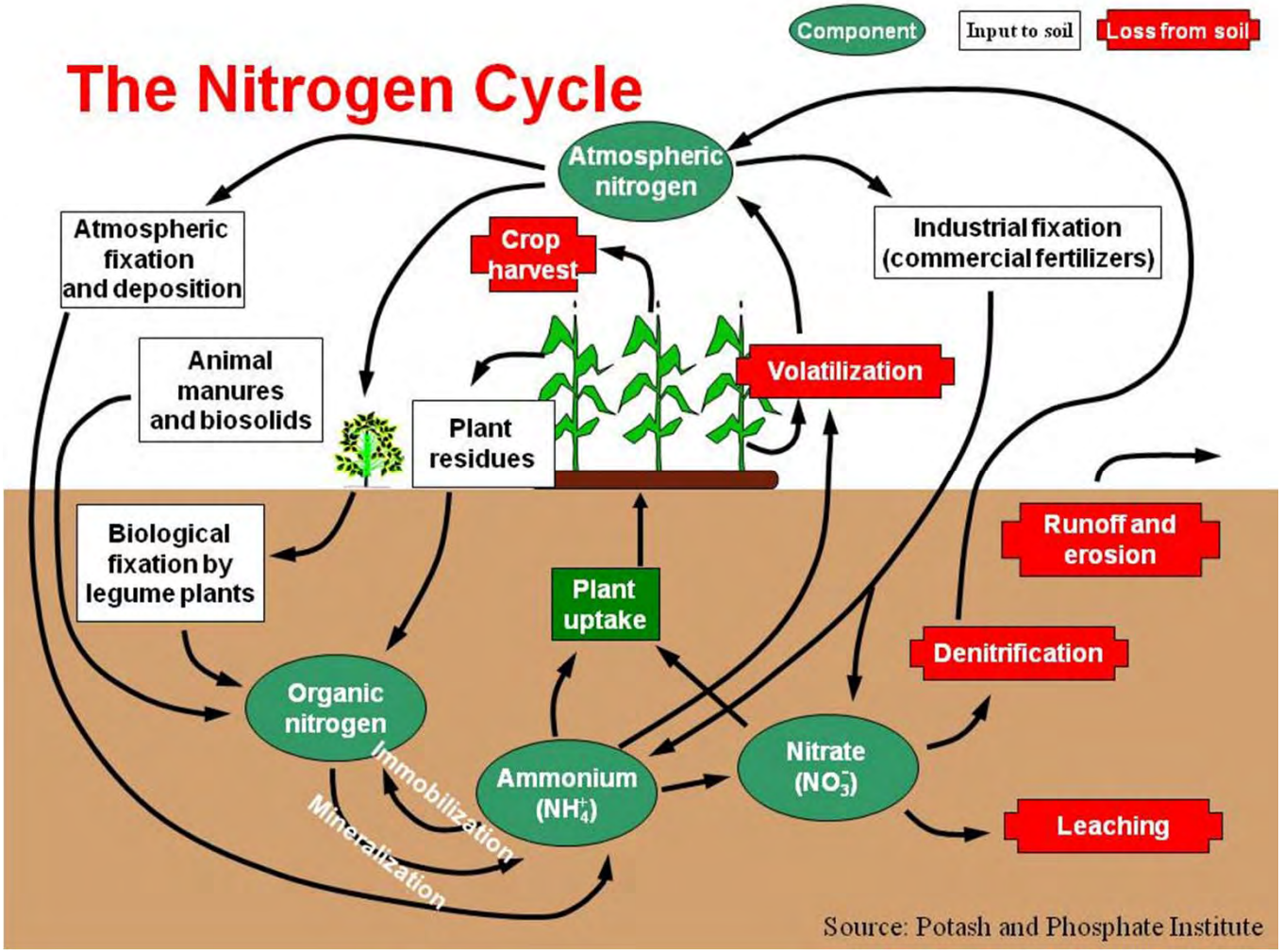
Nitrogen Supply

(Contribution from Legumes)

Legumes



Integrated System – An Ecologically Sustainable Approach



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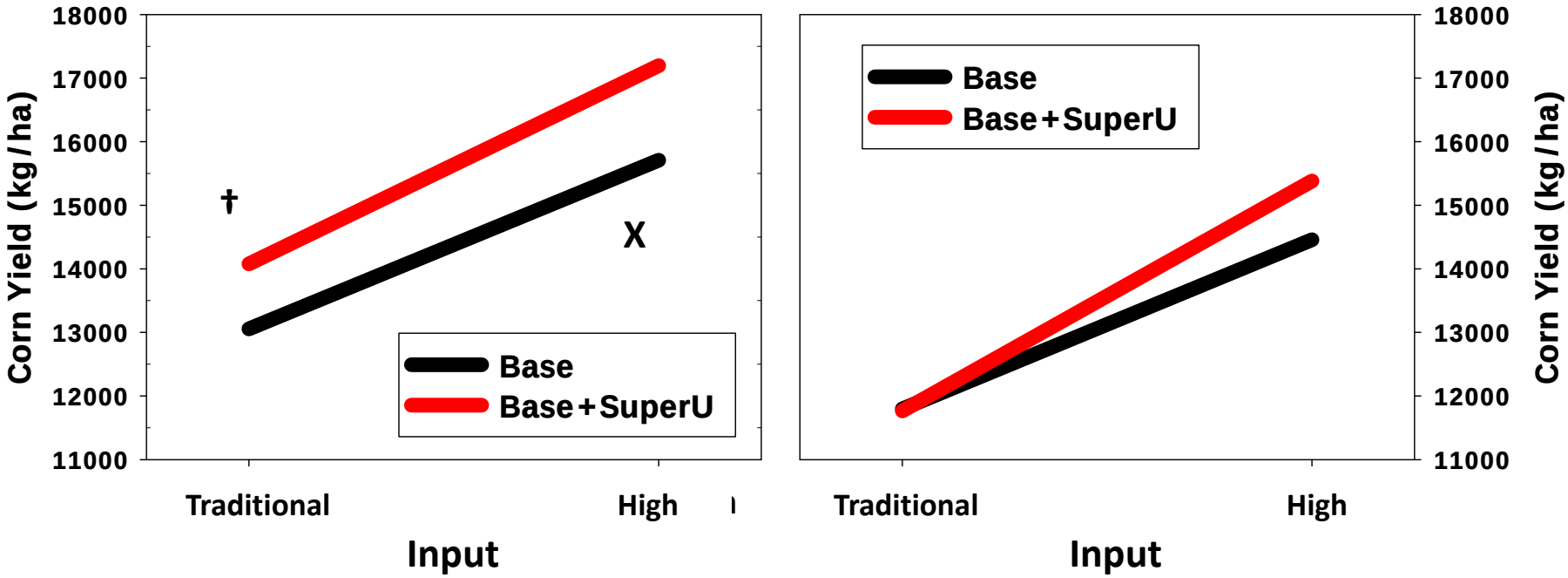

High input includes added MESZ, SuperU, genetics, plant population and fungicide

Conclusions – Strive for $e=mc^2$

100% Fertilizer Recovery is NOT Sustainable

Fertilizer Recommendations Should be Made in the Context of the 4R Program

- Right Rate
- Right Source
- Right Placement
- Right Time