

Nitrogen Management in Irrigated Soils

Nutrient Management Conference

Feb. 7, 2017, St. Cloud, MN

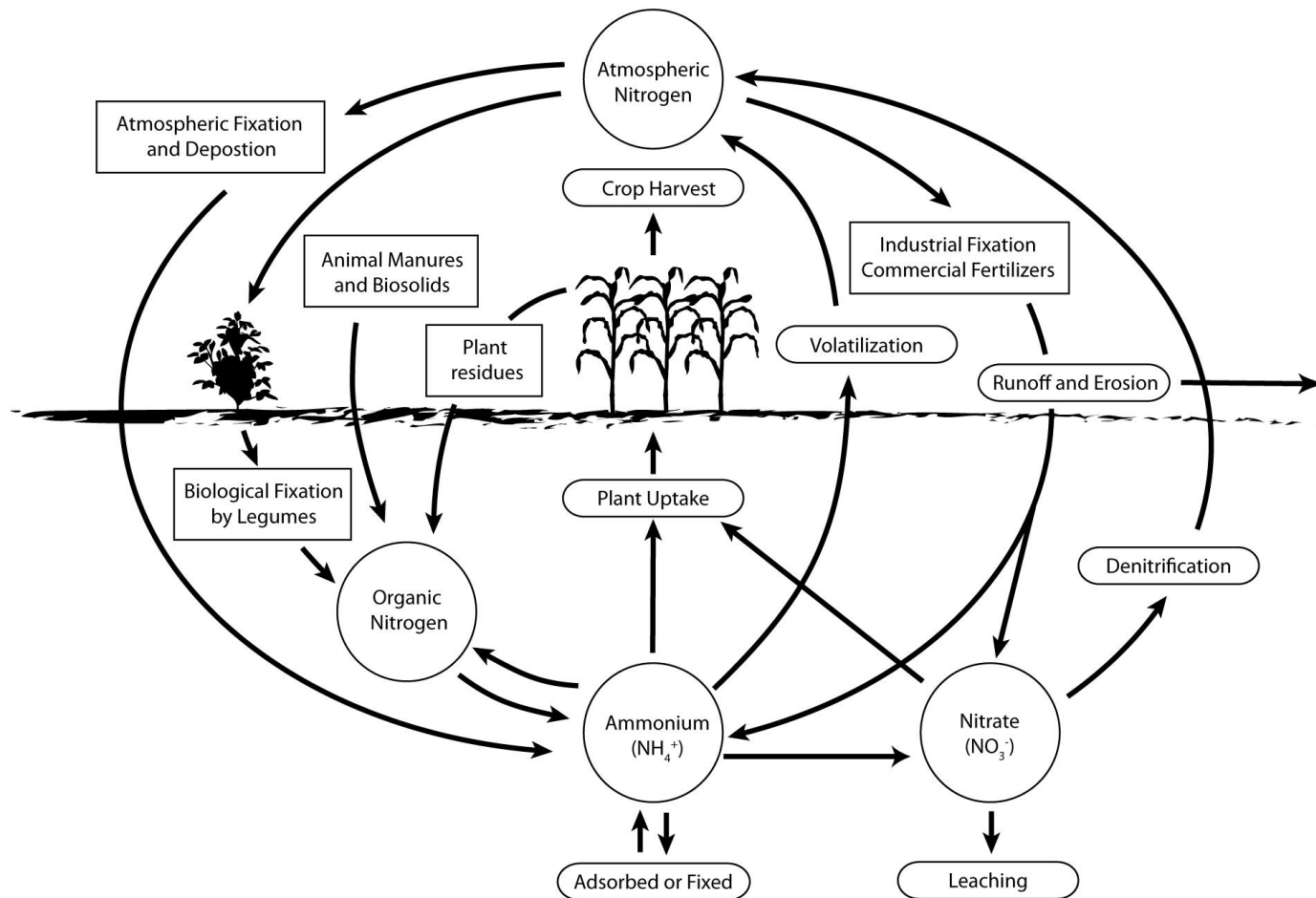
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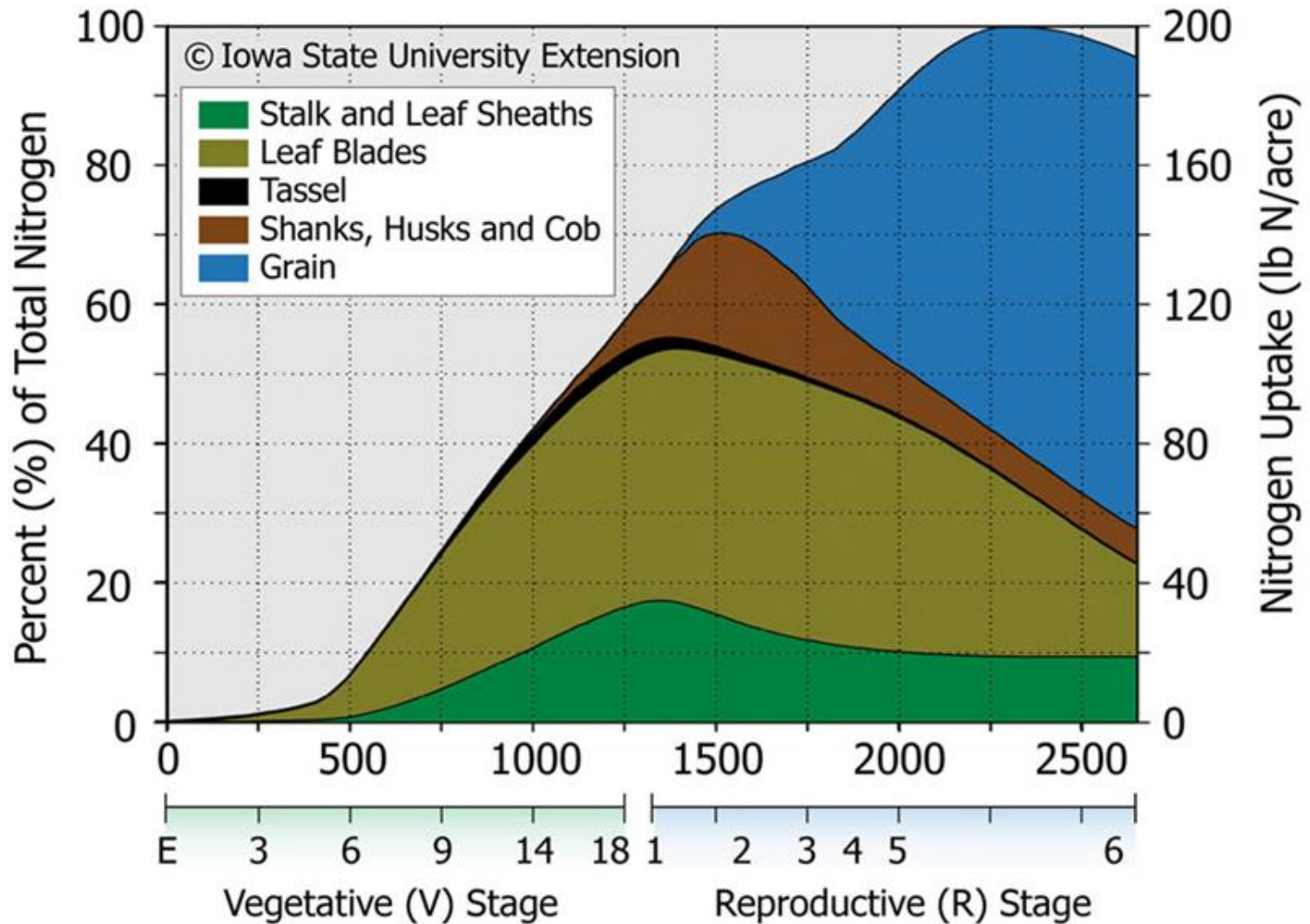
Objectives

- Understand the Nitrogen Cycle
- Crop Uptake Needs and Timing
- Pros and Cons of Nitrogen Forms
- Make the Best of a Leaky System

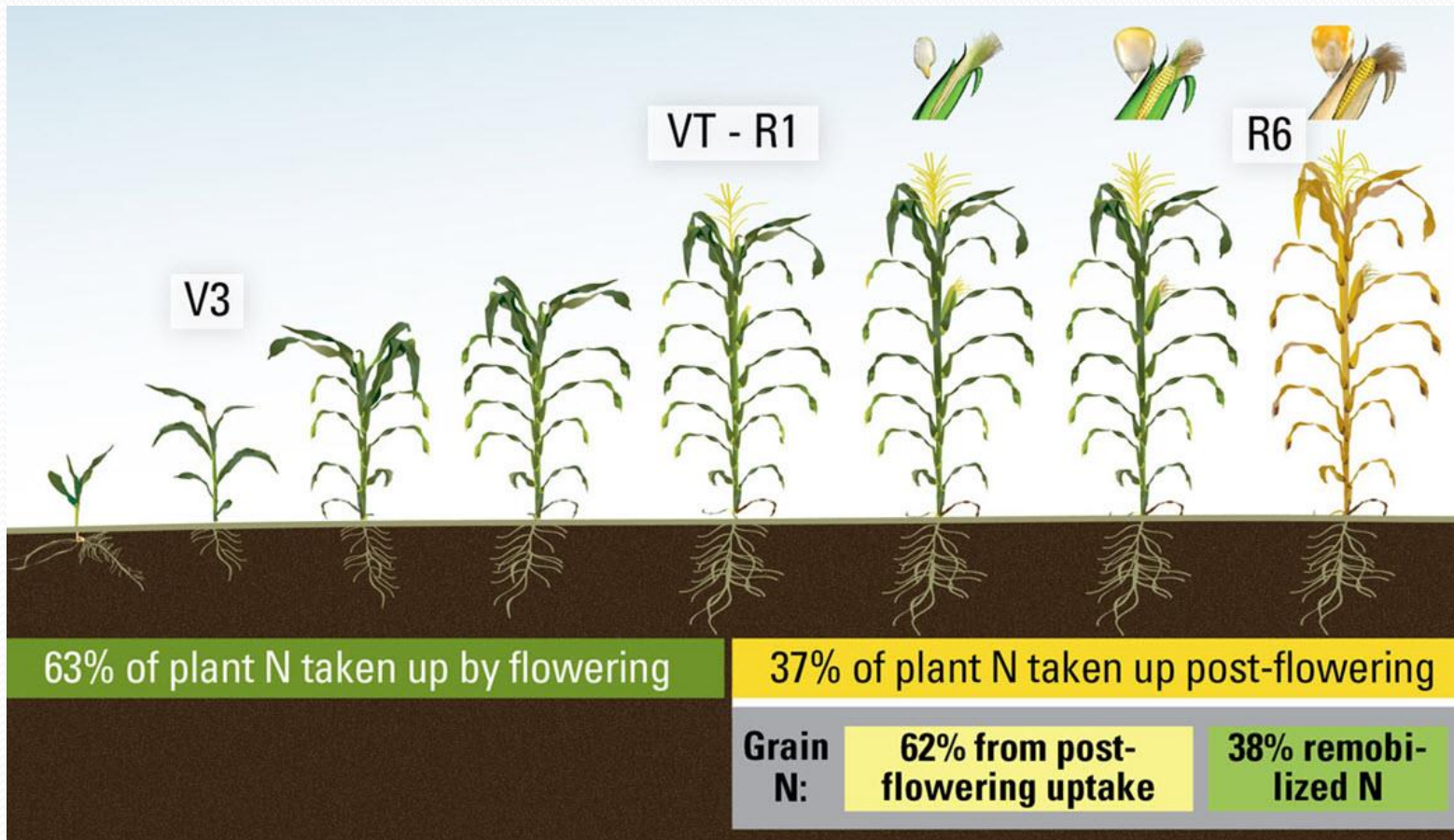
The Nitrogen Cycle



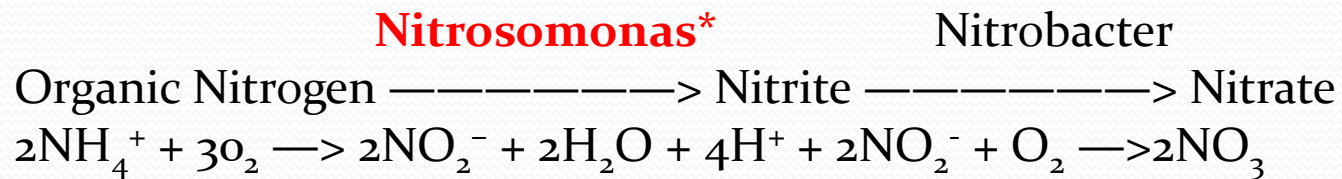
Nitrogen Uptake



Nitrogen Partitioning

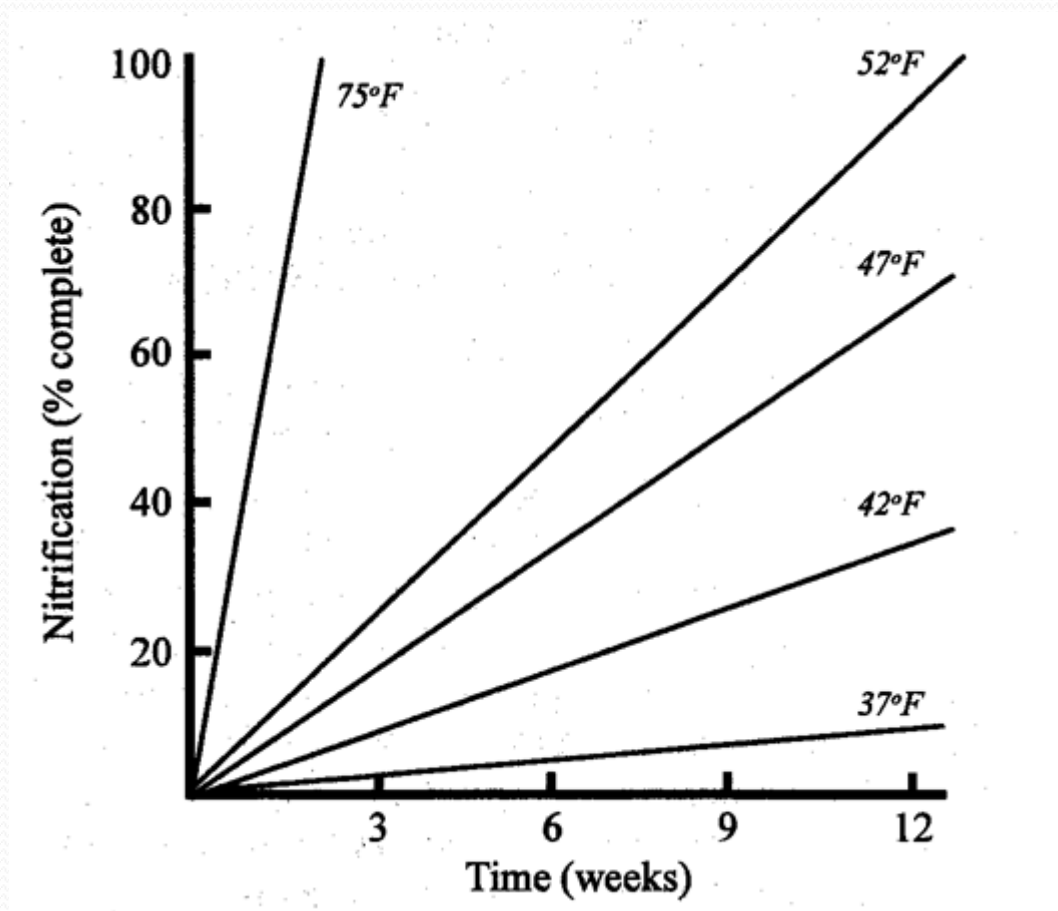


Soil Bacteria Influence Nitrification



*** Nitrification Inhibitors (nitrapyrin, DCD) interfere with this bacteria**

Reductions in Nitrification based on Temperatures



Adapted from Western Fertilizer Handbook, 1995

Possible Technologies to Improve N Use Efficiency

Stabilized nitrogen

- Slow conversion of urea to ammonium (urease inhibitor)
- Slow conversion of ammonium to nitrate (nitrification inhibitor)

Slow release nitrogen

- Form long chain N compounds
 - Methylated urea (generally expensive to produce)

Controlled release nitrogen

- Physical or chemical barrier to slow down solubility
 - Polymer coating around the fertilizer prill
 - Sulfur coating around the prill

Cover crop cocktails??

Urease Inhibitors

Agrotain (NBPT)

Limus (NBPT + NPPT)

- Slows down the conversion of urea to ammonia
- Reduces ammonia volatilization from surface-applied urea/UAN

Combination Urease/Nitrification Inhibitors

Agrotain Plus and SuperU

- Agrotain Plus formulated for use on UAN (liquid N products)
- SuperU formulated for use on urea
- Combination of NBPT and DCD
- Slows down the conversion of urea to ammonium
- Slows down the conversion of ammonium to nitrate
- Reduces ammonia volatilization and nitrate leaching (although DCD can leach)

Nitrification Inhibitors

N-Serve/Instinct II/Instinct HL* (*available fall 2017)

- Bactericide (nitrapyrin) registered for use on corn or wheat
- Nitrapyrin is very specific in its activity – reduces *Nitrosomonas* only
- N-Serve formulated for use with anhydrous ammonia
- Instinct II formulated for use with urea, UAN and liquid manure
- Instinct II is microencapsulated nitrapyrin



Nutrisphere-N

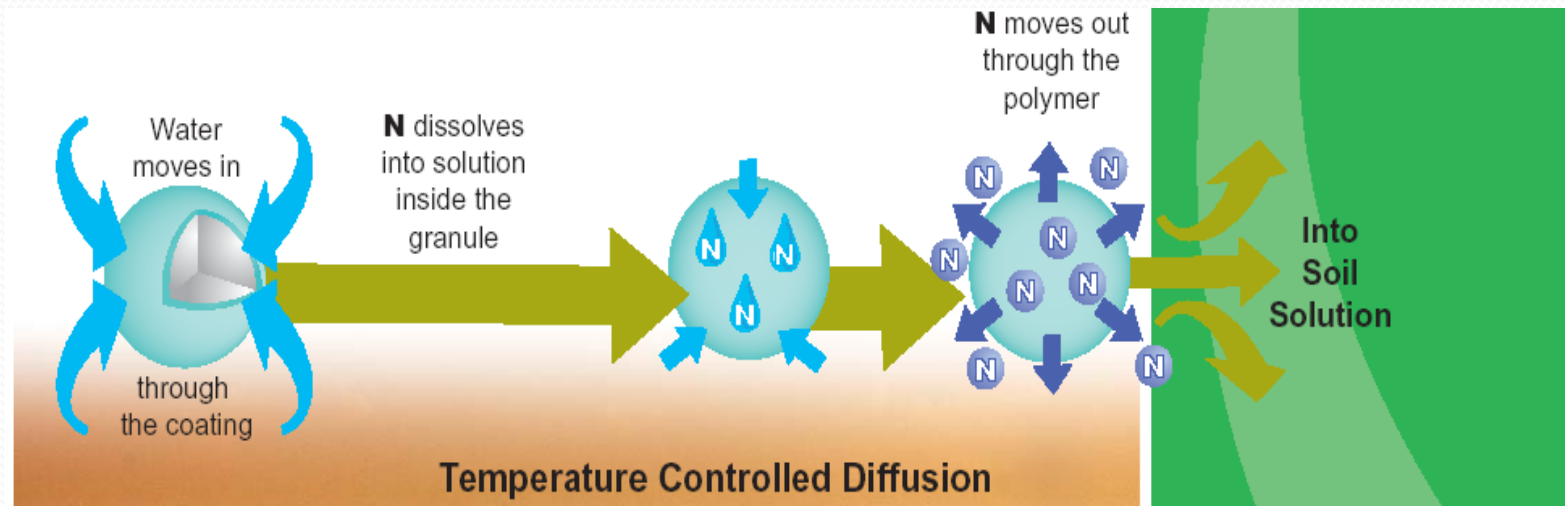
Water soluble co-polymer produced by Verdesian Life Sciences

- Originally developed to improve phosphorus availability (Avail)
- Mode of action is unclear – studies at NDSU show no urease inhibitor activity

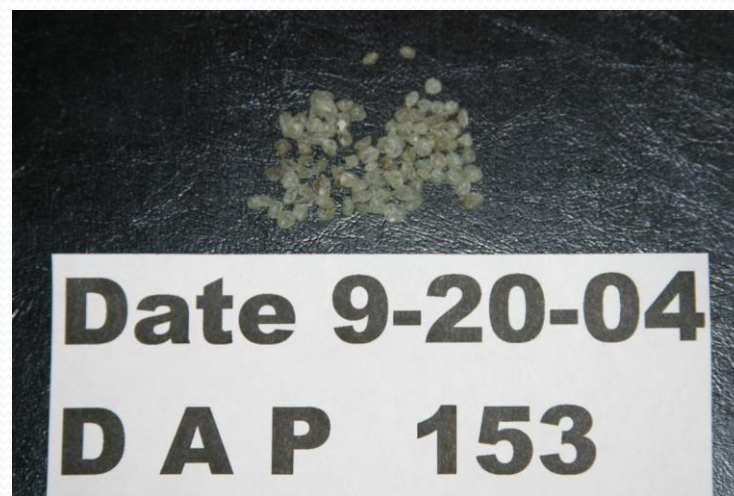
ESN (Environmentally Smart Nitrogen)

Coated urea

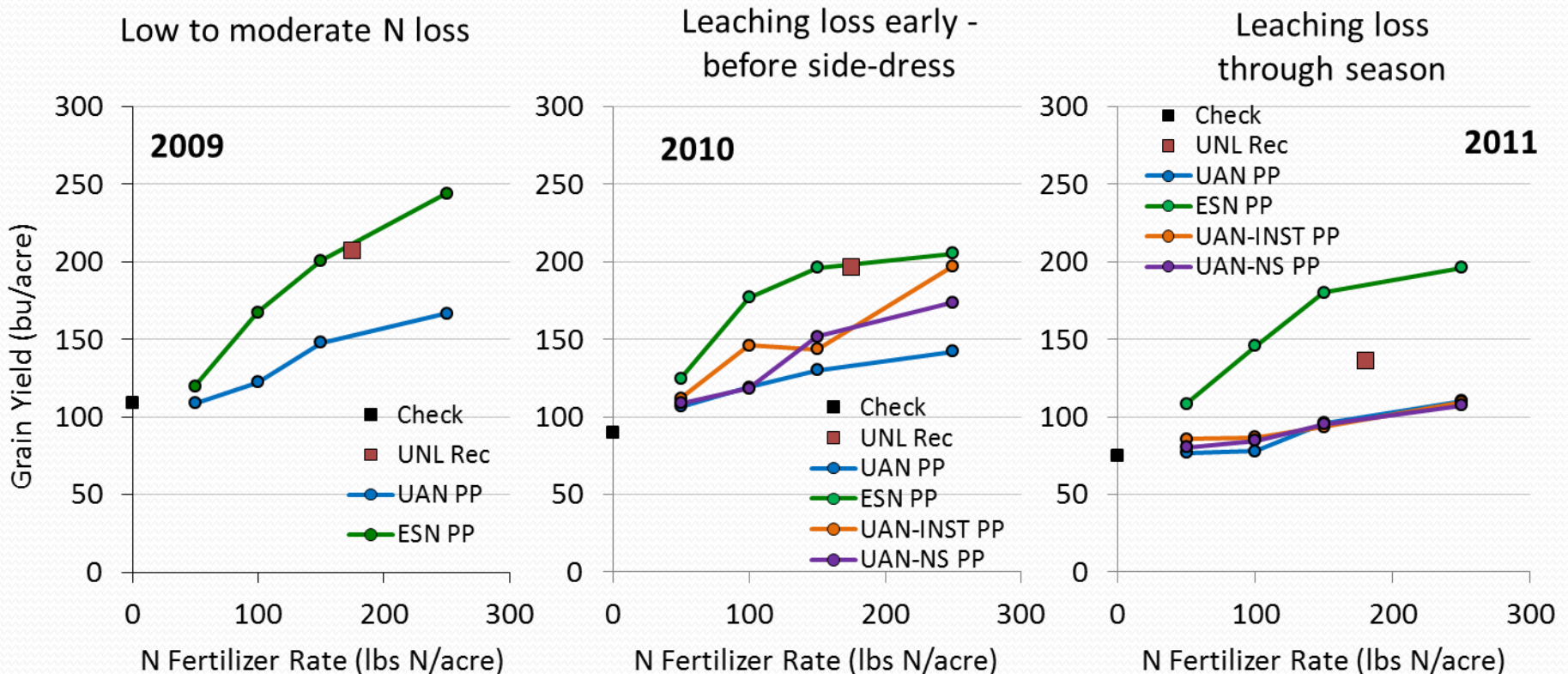
- Release rate depends on soil moisture and temperature



Visual assessment of
ESN prills through the
growing season



NE Sprinkler Irrigated Corn on Sandy Soils



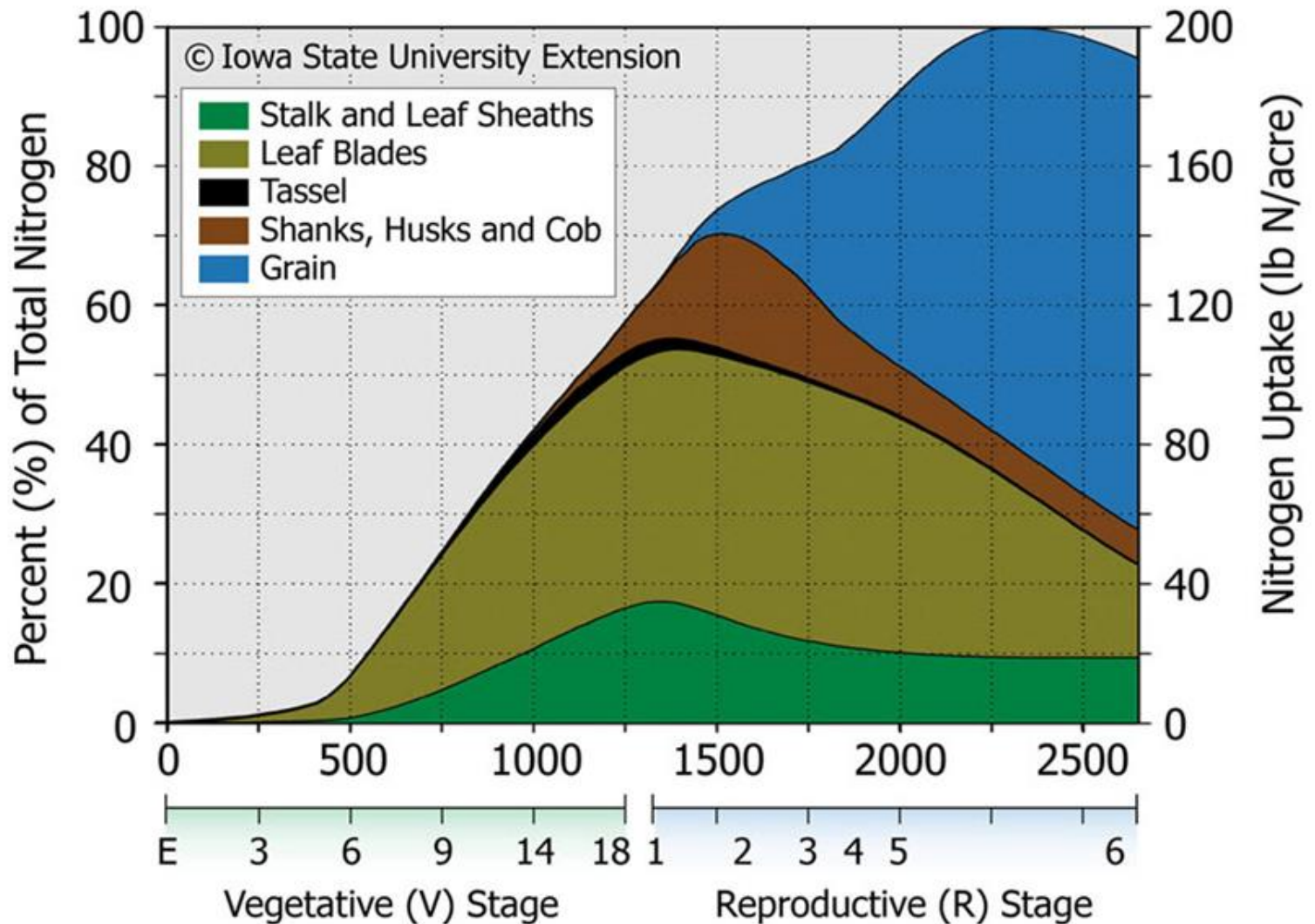
Dr. R. Ferguson, Univ. of NE, Agron. J. 2016

Where Did All My Nitrogen Go??

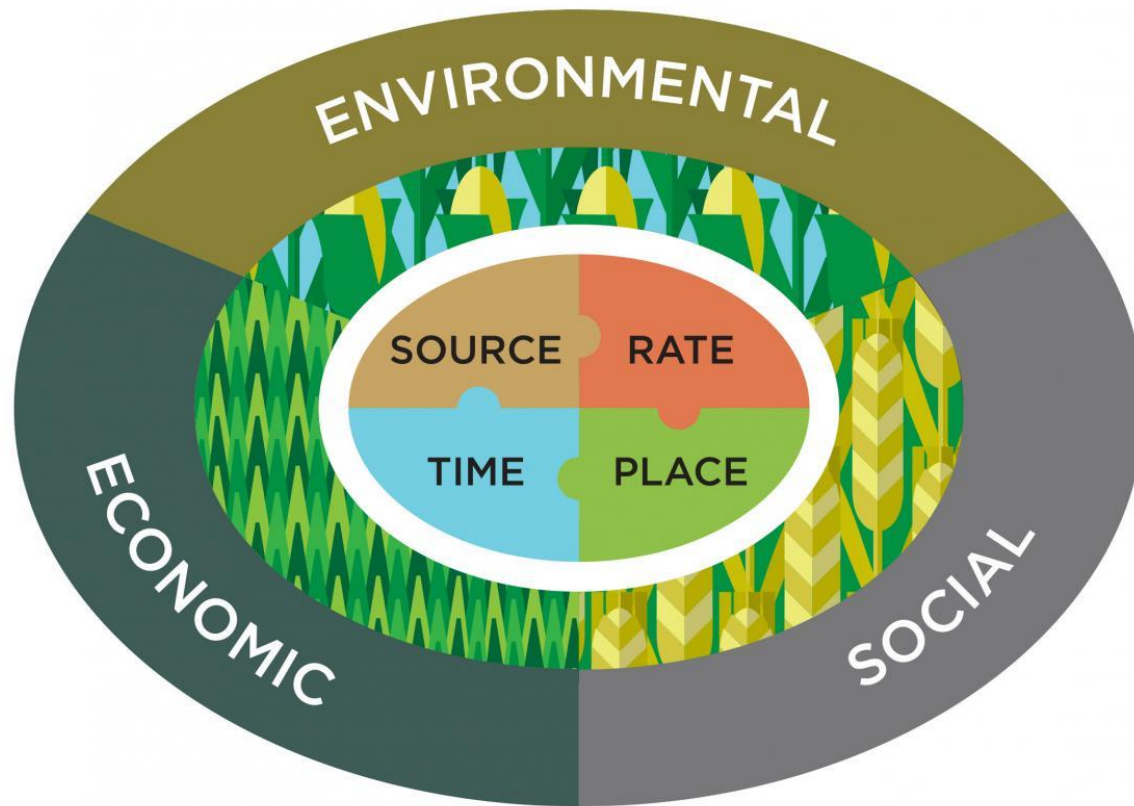
Approximate Wetting Depth

<u>Texture</u>	<u>2" Rain</u>	<u>4" Rain</u>
Sand	34	69
Sandy Loam	18	37
Loam	13	27
Clay Loam	11	23

Nitrogen Uptake



4 R's of Nutrient Management



Percent of surface-added urea volatilized as ammonia at various soil pH levels and days on the surface

Soil pH						
Days	5.0	5.5	6.0	6.5	7.0	7.5
(% of added N volatilized)						
0	0	0	0	0	0	0
2	0	0	0	0	1	5
4	1	2	5	10	18	20
6	4	5	7	11	23	30
8	8	9	12	18	30	33
10	8	10	13	22	40	44
Data from SSSP 24, pages 87-90, 1960. Urea added on silt loam soil at 100 lb. N.						

Strategies for Reducing Ammonia Volatilization Losses

Researchers analyzed 171 studies spanning 1971 to April 2016
(cropping and pasture systems)

Findings:

- Irrigation decreased volatilization by 35% compared to rainfed or minimal IR
- Surface residue increased losses by 26%
- Urease inhibitors reduced losses by 54%
- Controlled release fertilizers reduced losses by 68%
- Volatilization decreased by 65% with incorporation relative to surface applications

Take-home messages:

- Global demand for N fertilizers in 2014 was 112 million tons
- Currently accepted that 10 to 20% of all N applied is lost to volatilization
- 11 to 22 million tons of fertilizer N were lost in 2014 due to volatilization
- That's a CO₂ equivalent of 52 to 105 million tons!!

Are we sure we're doing all we can???

Anhydrous Ammonia (NH_3)

Advantages

- Injected as a gas into the soil preplant or sidedress
- High analysis requires less handling, storage and transportation costs than others
- Lowest cost product per pound of N
- Injection into moist soil reduces “positional unavailability of N” present with surface-applied products if topsoil surface is dry
- Form of N most resistant to leaching and denitrification losses

Disadvantages

- Higher power requirement for application if not combined with tillage
- Requires high-pressure storage and handling equipment
- Requires high level of safety awareness
- Soil too dry or too wet at application leads to improper sealing and loss of gas
- Soil disturbance at sidedress injection allows for weed seed germination potential
- Crop germination issues if injected too shallow in spring ($<4"$)
- Soil bacterial populations directly at injection point reduced for < 3 days

Urea (46 – 0 – 0)

Advantages

- Applied to soil preplant or sidedress
- Little or no fire or explosion hazard
- High N analysis dry product reduces handling, storage and transportation costs
- Manufacture of urea releases few pollutants into the environment
- Very soluble product

Disadvantages

- Poor quality control and/or excessive handling results in poor application patterning with spinner spreaders
- Lighter density fertilizer product requires narrower spread pattern with spinners
- Needs incorporation into soil to reduce volatilization losses
- Late postemerge applications result in significant leaf burn and likely yield loss

Nitrogen Solutions (28 – 0 – 0 and 32 – 0 – 0)

Advantages

- Quickest crop response form of N available
- No high-pressure equipment needed for storage or application
- Less power required for application than with anhydrous ammonia
- Can be combined with compatible herbicides, insecticides and fungicides if desired
- Can be applied with high clearance sprayer late season
- Can be injected into the irrigation stream and applied late season
- Easy to prescription apply in-season

Disadvantages

- Formed by combining 50% urea and 50% ammonium nitrate, so about 25% of N is in a readily leachable form at time of application
- Generally higher cost per pound of N than dry or gaseous nitrogen
- Urea portion of liquid N source is susceptible to volatilization losses with surface applications
- Potential for excessive crop injury if applied undiluted following crop emergence

Livestock Manure

Advantages

- Organic and inorganic nitrogen forms result in slow N release to crops
- Asset to cropping enterprise if storing, transportation and application costs are all charged to the livestock enterprise
- Carries a mixture of N, P, K, S, Zn and an “unmeasurable factor” that adds more yield than equivalent inorganic fertilizer additions
- Bedding pack manures can increase soil tilth, water-holding capacity and protect fragile soils from wind or water erosion

Disadvantages

- Organic nitrogen forms are unpredictable in their release rates
- Slow application rate per hour
- Additional labor demands or custom application charges
- Risk of soil compaction
- High rate of N application early in season to “empty the pit”
- Ratios of N, P and K may not be well-suited to crop rotation fertilizer requirements

Fertilizer Nitrogen Cost Comparisons (\$/lb. of N)

Form of N	\$/lb. N
ESN (44 - 0 - 0)	0.54
82 - 0 - 0	0.31
46 - 0 - 0	0.38
32 - 0 - 0	0.39
28 - 0 - 0	0.48
AMS (21 - 0 - 0 - 24 S)	0.44

Local Corn Cash Price	\$3.10/bu
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N Price/Corn Value Ratio	0.10 to 0.17
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Effect Of 20 Years Of N Fertilizers On Soils. (Kansas State University)

Nitrogen Source	Soil pH
Check(No N)	6.2
Anhydrous Ammonia	5.2
Ammonium Nitrate	5.2
Urea	5.1
UAN Solution	5.2

Conclusions

- Make informed, sound N management decisions
- Be prepared to react to this year's weather conditions
- Take realistic credits for legumes, manure and early season warmth
- Don't put all your eggs in one basket
- Talk to your banker before "shooting for the moon" – he/she may have another idea!
- Implement a good weed control program – weeds love nitrogen too!