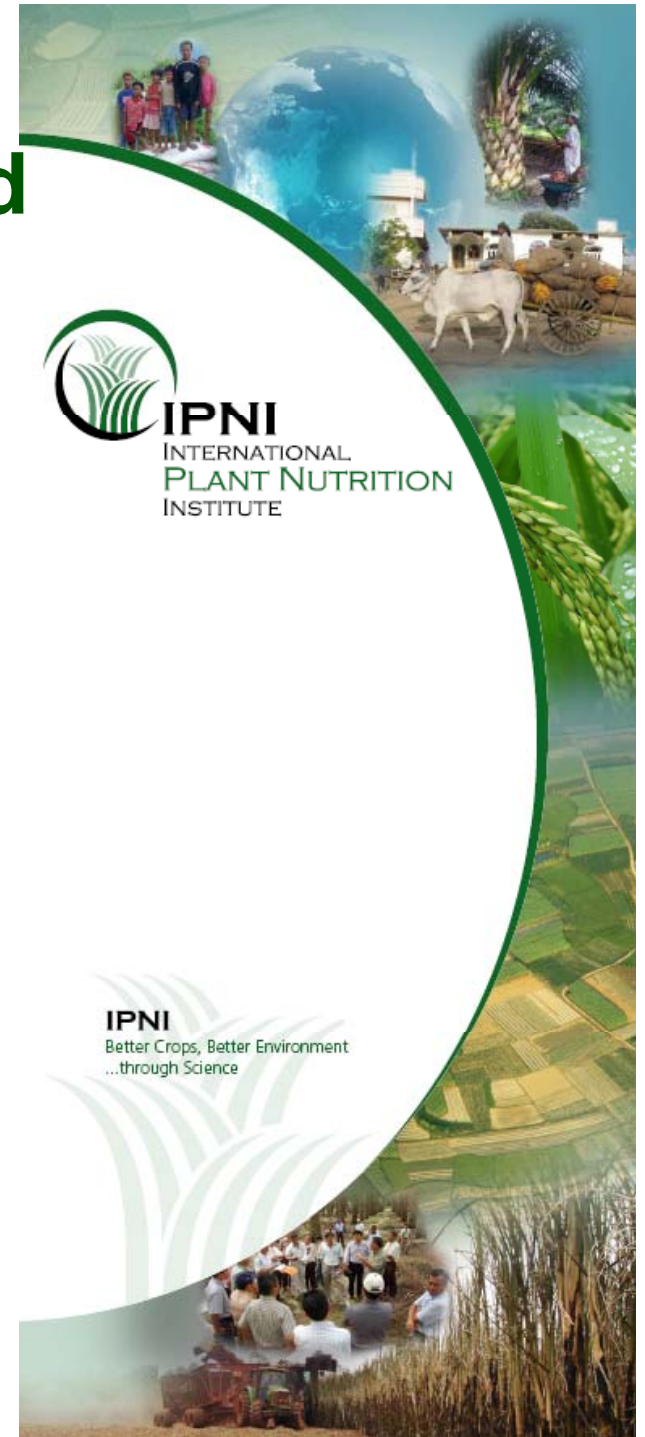


Nitrogen Dynamics Associated with Nutrient Management Practices

... Moving Forward

Rob Mikkelsen
Director, Western North America
Merced, CA



Nitrogen Fertilizer Plays a Vital Role in Civilization

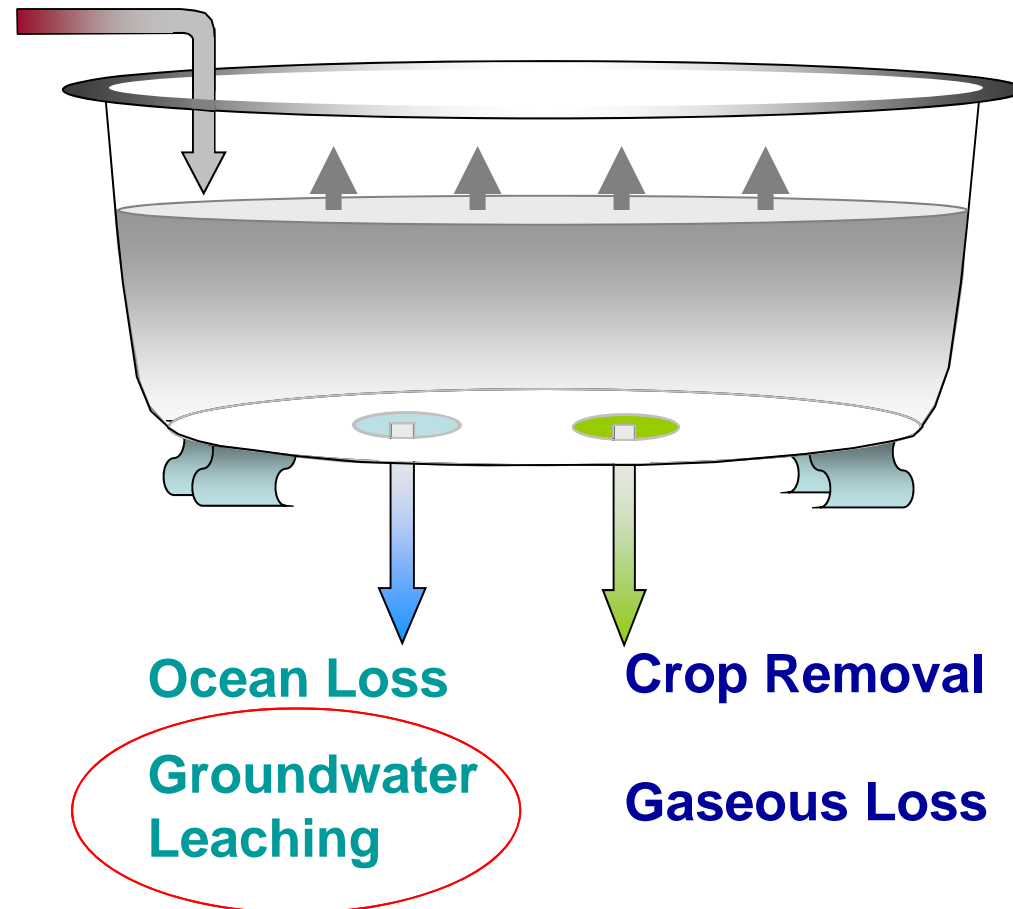
“Without the use of N fertilizers, we could not secure enough food for the prevailing diets of nearly 45% of the world’s population, or roughly 3 billion people...” [Smil, 2011]



Smil, V. 2011. Nitrogen cycle and world food production. *World Agriculture* 2:9-13.

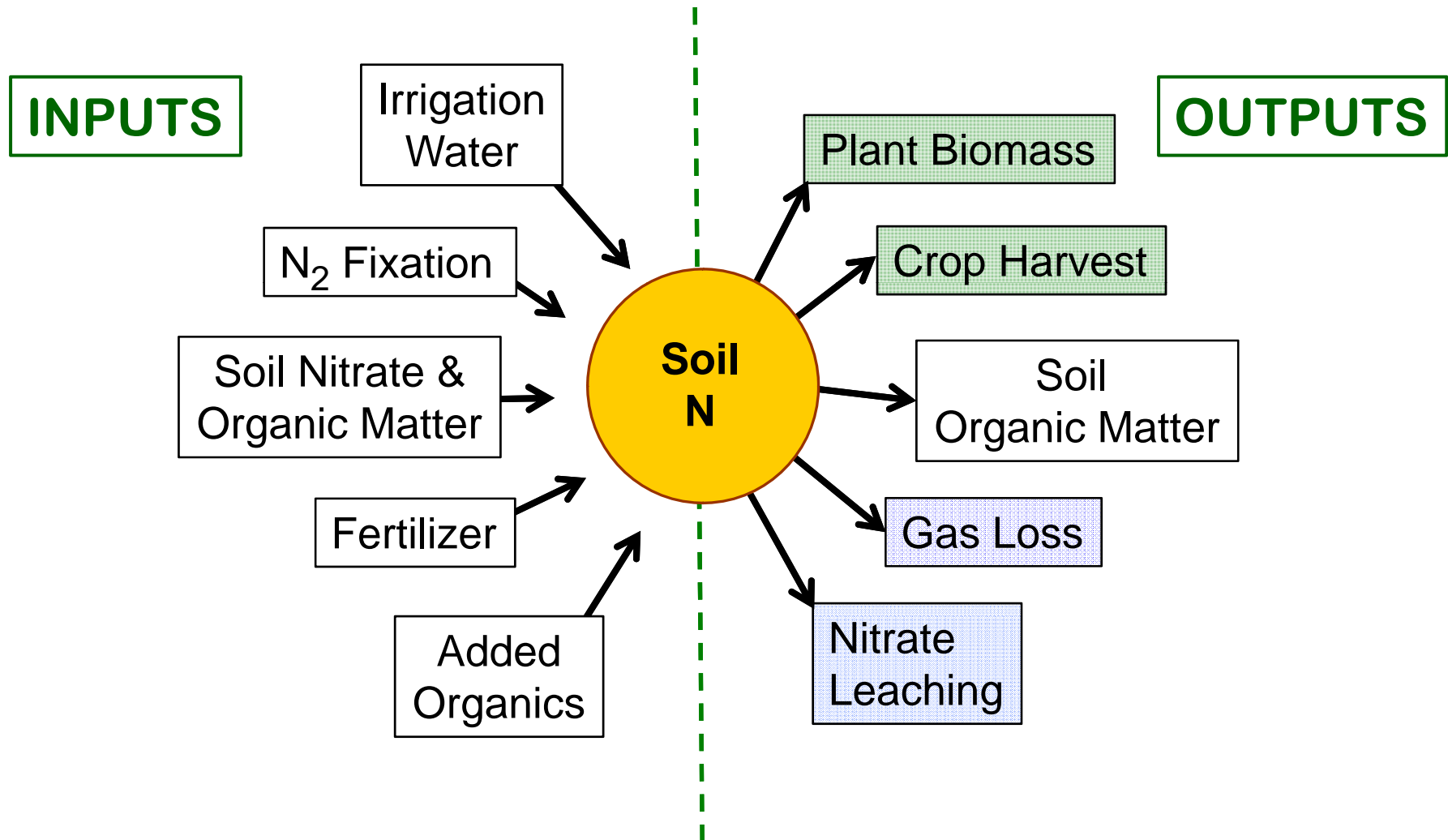
- Fertilizer
- Fixation
- Deposition
- Ag imports

Nitrogen Mass Balance



Reality:

Agricultural Nitrogen Management Challenge

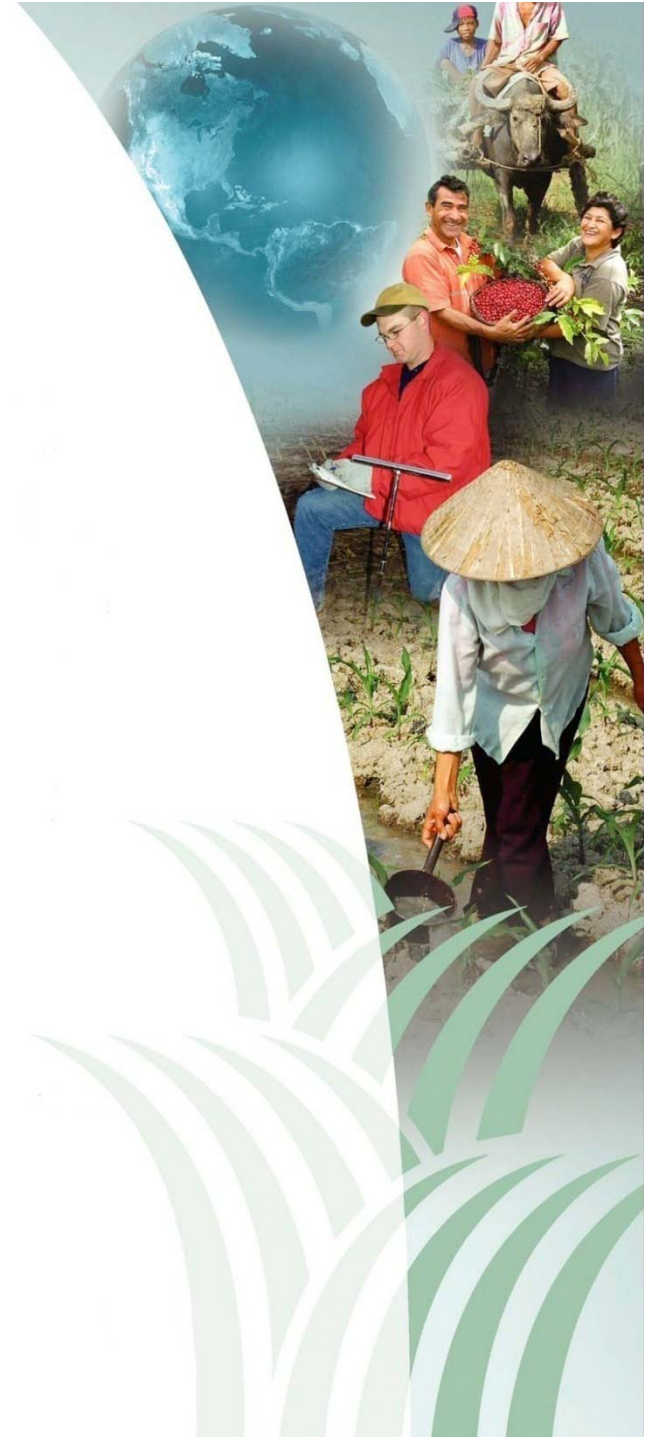


Many processes are variable, uncontrollable, or poorly predicted

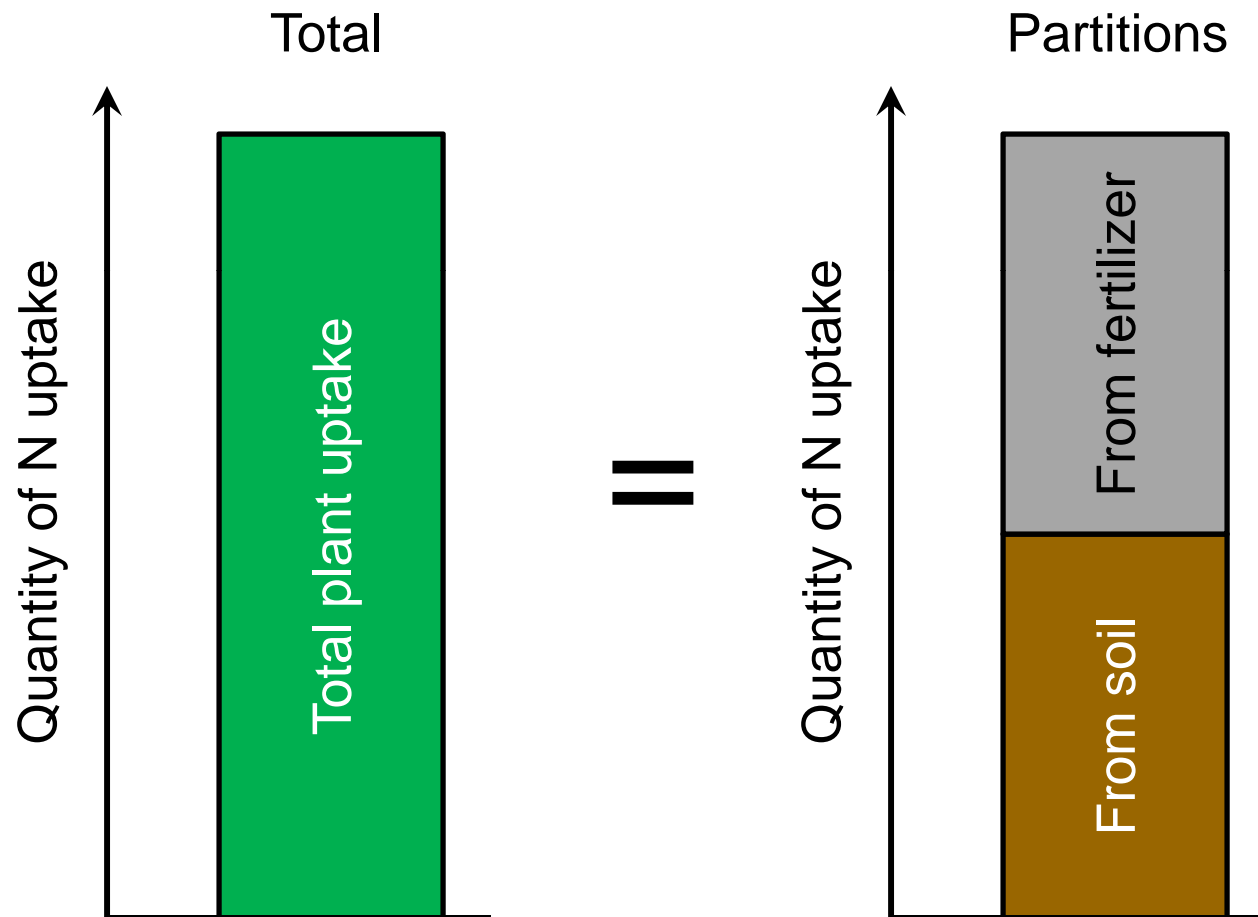
What is nutrient efficiency?

**What should nitrogen
partial nutrient balance be?**

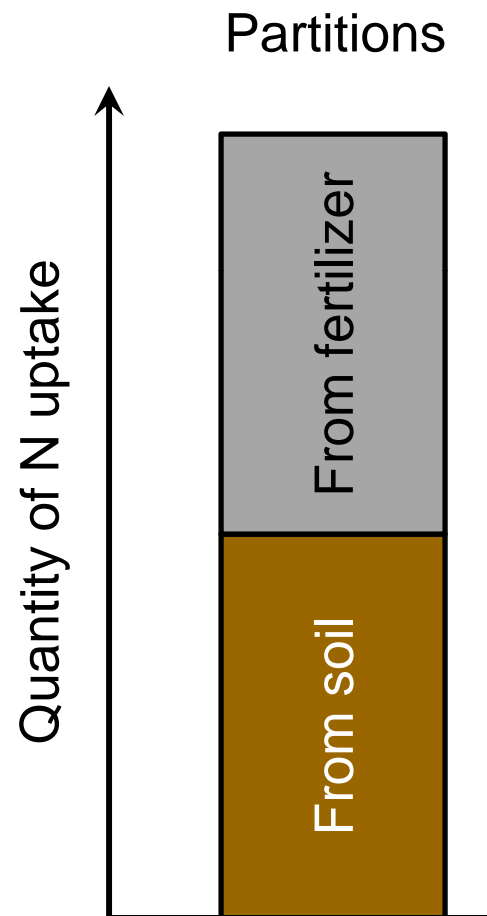
What do you need to know?



Foundational theory of N rate recommendations



Foundational theory of N rate recommendations

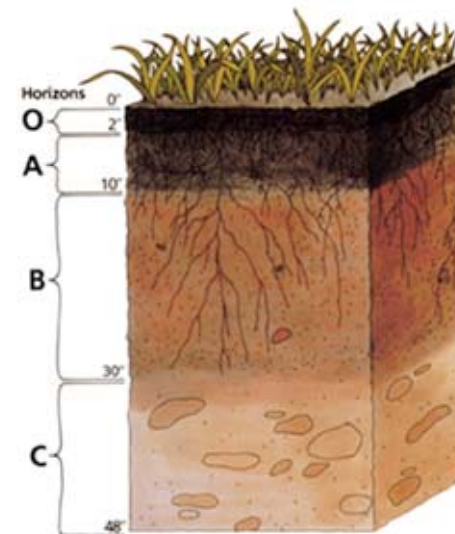


The fertilizer recommendation must:

- Make up for the difference between
 - total uptake requirements, and
 - how much is obtained from the soil
- Account for how much of the fertilizer applied actually gets utilized by the plant
 - Apparent crop recovery efficiency (RE)

Fertilizer use efficiency

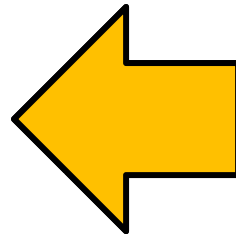
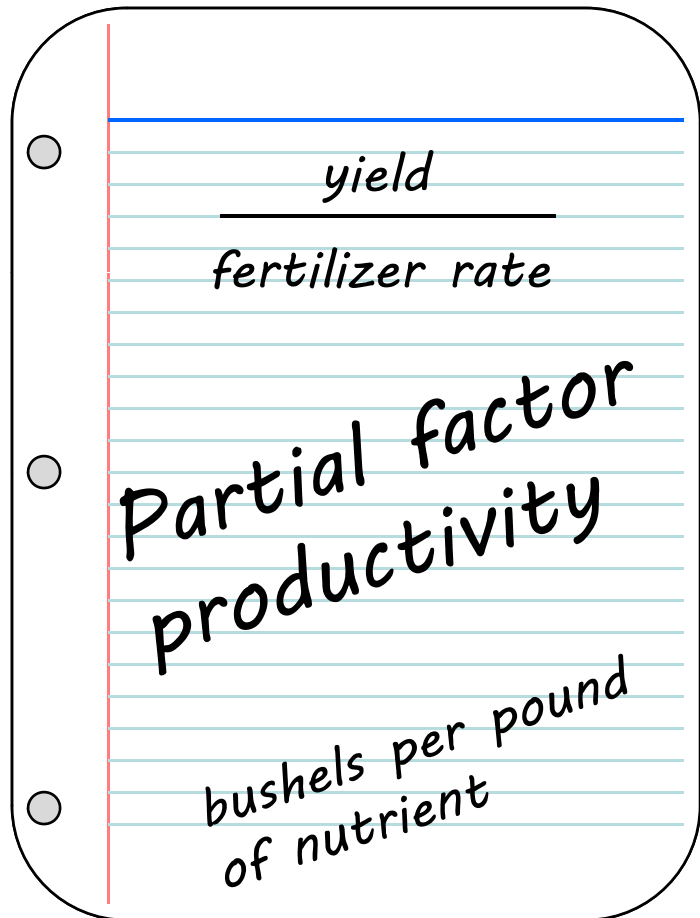
- Plants cannot utilize 100% of the externally applied nutrients due to inherent sinks and loss mechanisms
- Fixation by inorganic and organic soil components
- Microbial immobilization
- Leaching
- Volatilization



The “partial” of partial nutrient balance

Amount applied		Amount removed	
<input checked="" type="checkbox"/>	Fertilizer application	<input checked="" type="checkbox"/>	Crop harvest
<input checked="" type="checkbox"/>	Manure application	<input type="checkbox"/>	Leaching losses
<input checked="" type="checkbox"/>	Nutrients in irrigation water	<input type="checkbox"/>	Runoff losses
<input checked="" type="checkbox"/>	Nitrogen fixation	<input type="checkbox"/>	Erosion losses
<input type="checkbox"/>	Atmospheric deposition	<input type="checkbox"/>	Gaseous losses
<input type="checkbox"/>	Deposition from other landscape areas		

Making nutrient use efficiency something we can measure: Grain crop example



Things we can measure

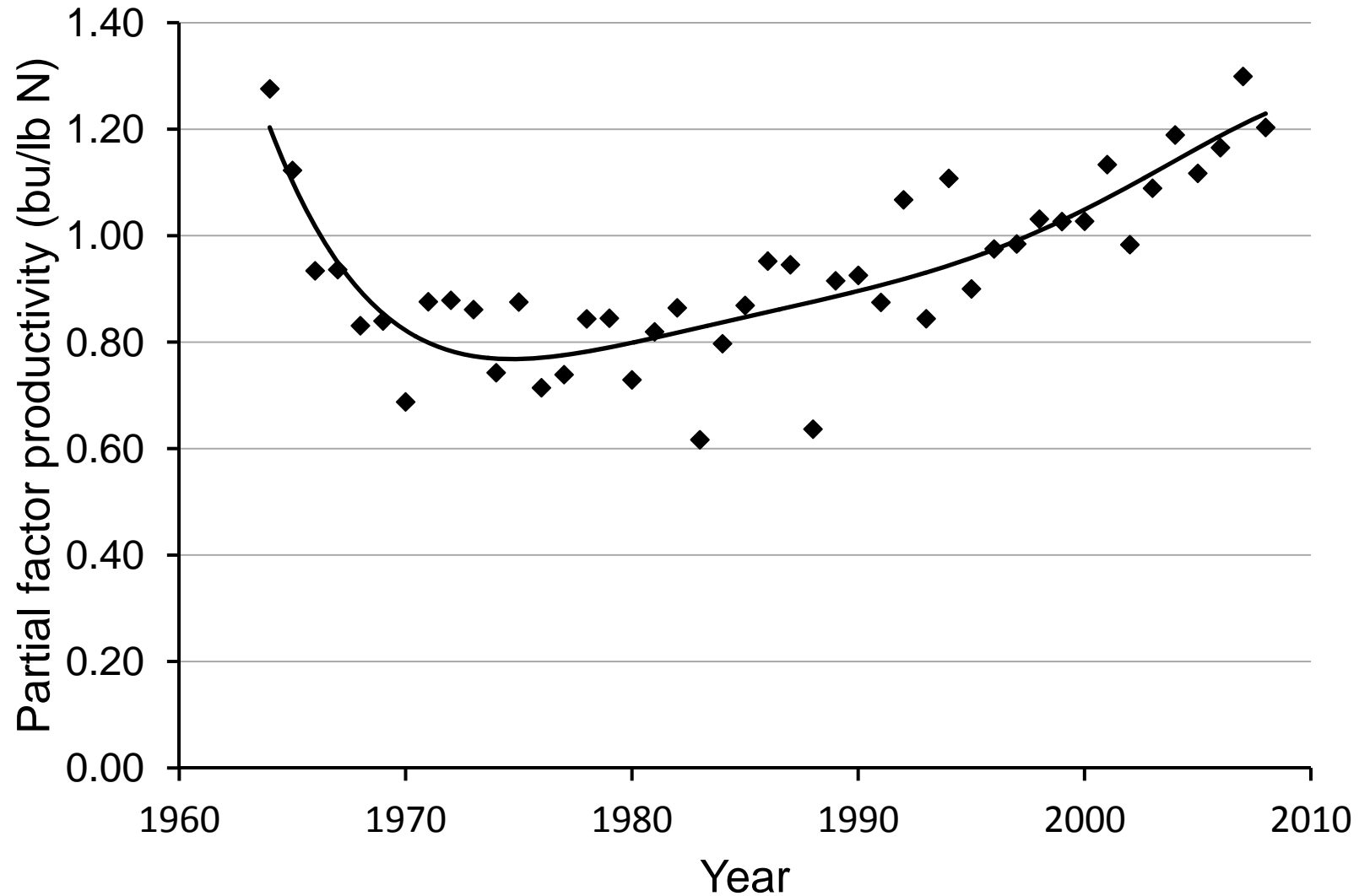
Grain yield of a fertilized crop

Grain yield of an unfertilized crop

Fertilizer application rate

Nutrient content of the grain

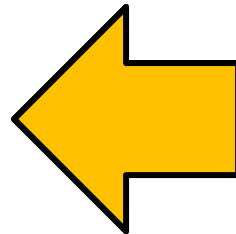
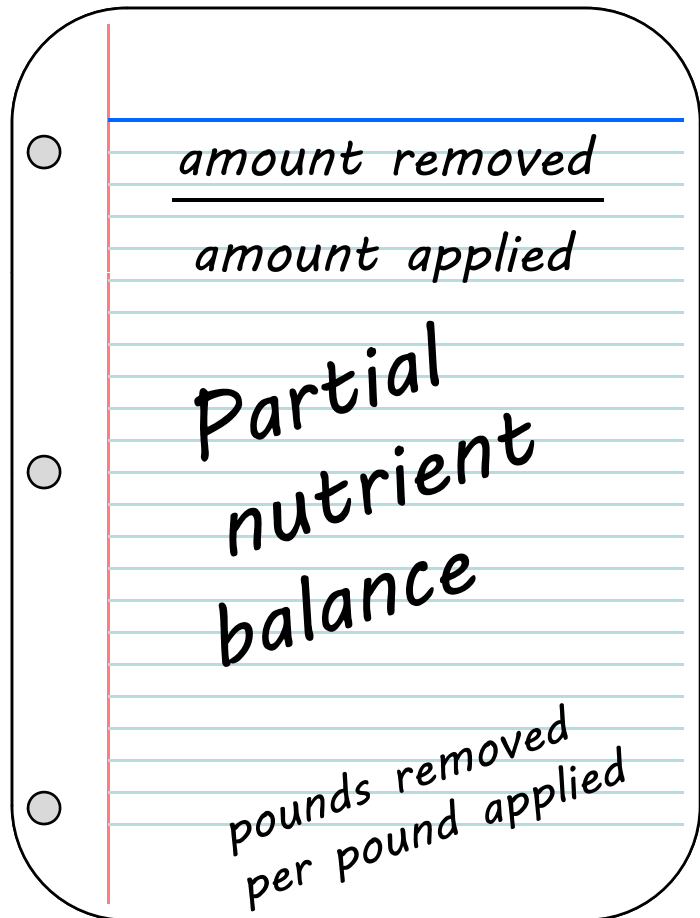
Partial factor productivity of nitrogen for corn grain: *Scale: U.S., 1964-2008*



Data: USDA-NASS, USDA-ERS



Making nutrient use efficiency something we can measure: Grain crop example



Things we can measure

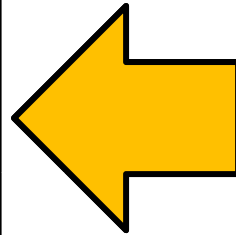
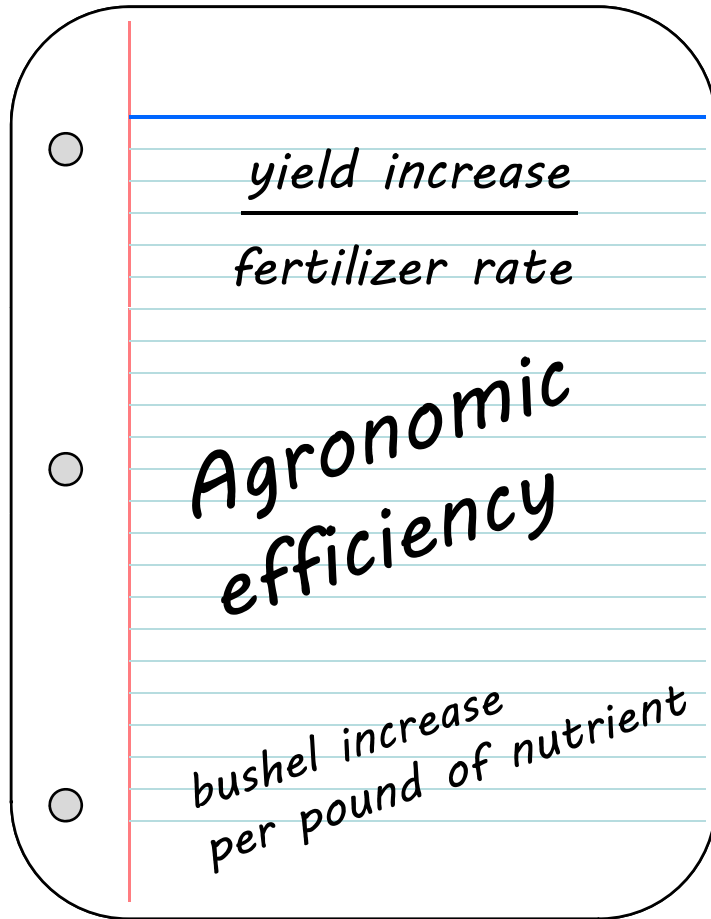
Grain yield of a fertilized crop

Grain yield of an unfertilized crop

Fertilizer application rate

Nutrient content of the grain

Making nutrient use efficiency something we can measure: Grain crop example



Things we can measure

Grain yield of a fertilized crop

Grain yield of an unfertilized crop

Fertilizer application rate

Nutrient content of the grain

The power of CCA's

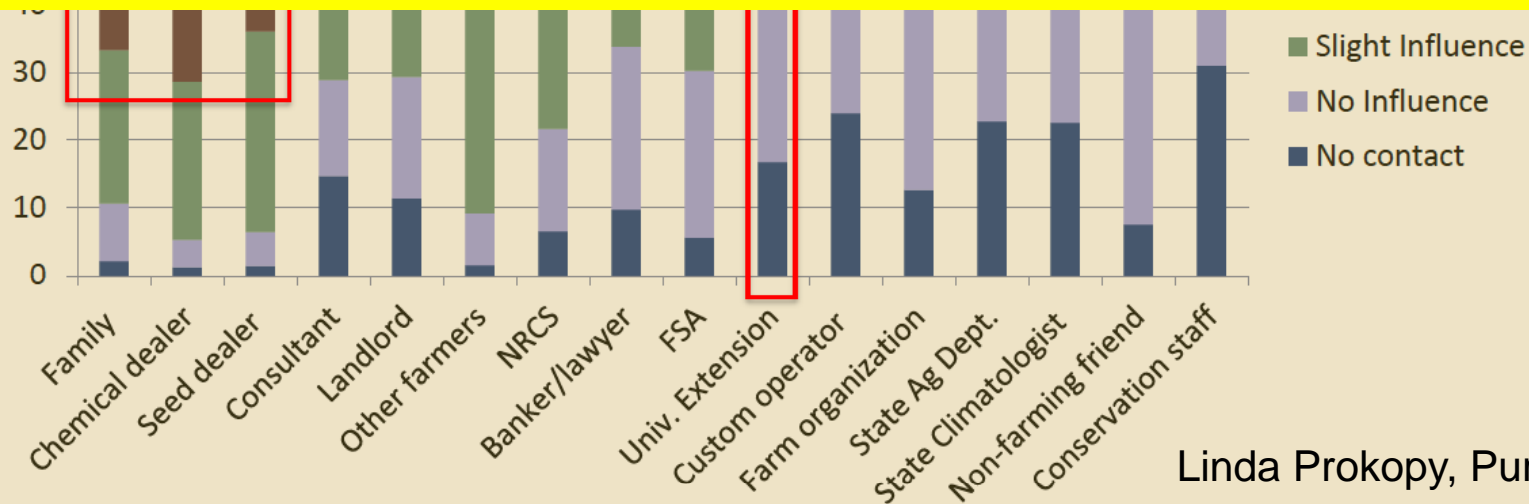
Where do farmers get their information?



Please indicate how influential the following groups and individuals are when you make decisions about agricultural practices and strategies. (16 options)



...the survey asked about the primary decision influencer for the decision maker. **Overwhelmingly, this was the "fertilizer dealer"** (Mike Schmitt, Univ Minn)



Linda Prokopy, Purdue



IPNI

INTERNATIONAL
PLANT NUTRITION
INSTITUTE



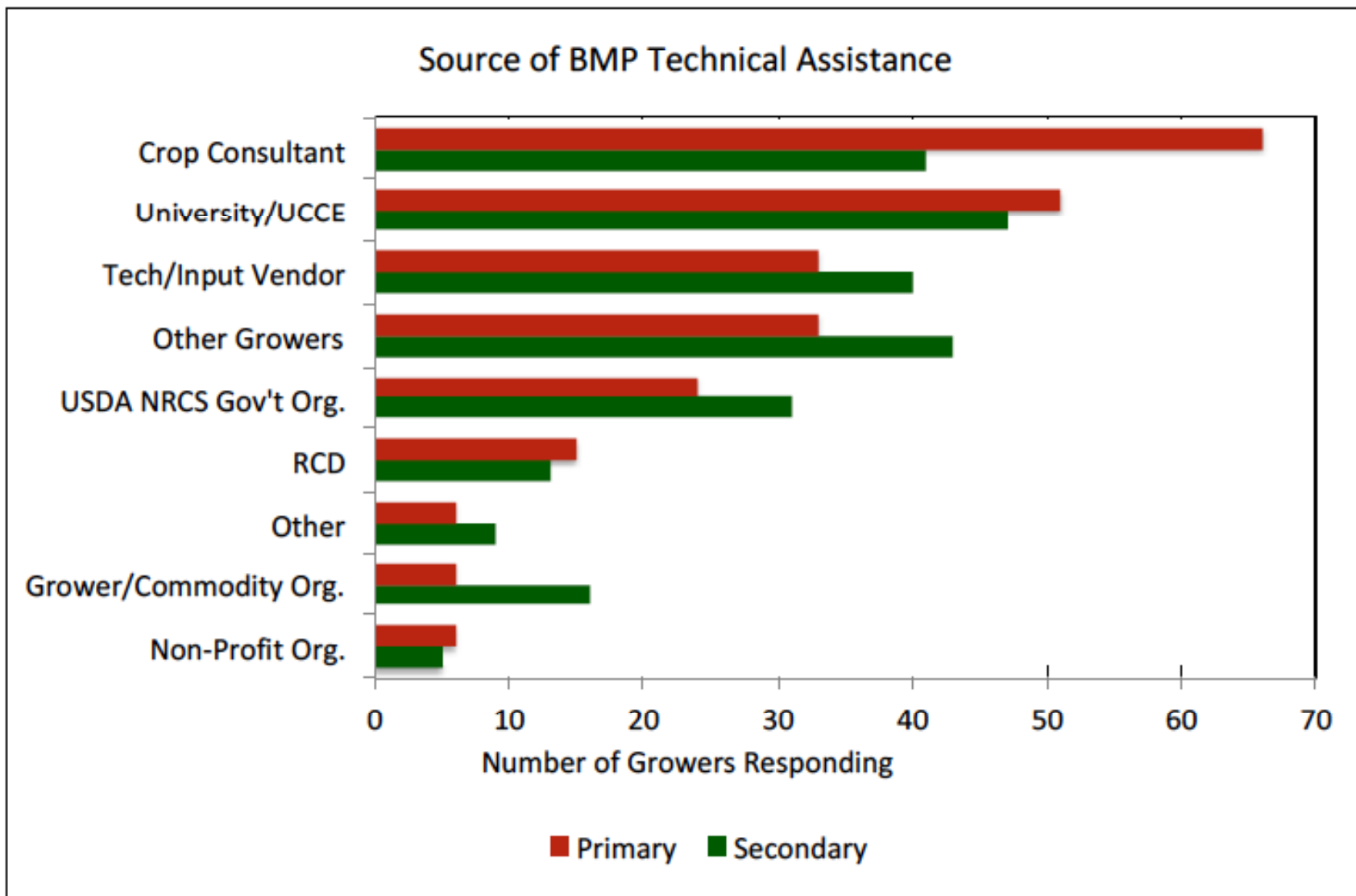
American Farmland Trust (Steve Shaffer) polled and held focus groups with specialty crop growers, asking them:

“what would make it more likely for you to try practices such as micro-drip, alternate furrow irrigation, and timed application and precise placement of nitrogen fertilizers.”

The results are contained in a American Farmland Trust report:

***Encouraging California Specialty Crops
Growers to Adopt Environmentally Beneficial
Management Practices for Efficient Irrigation
and Nutrient Management***

April 2013



*Encouraging California Specialty Crops Growers to Adopt Environmentally
Beneficial Management Practices for Efficient Irrigation and Nutrient Management*

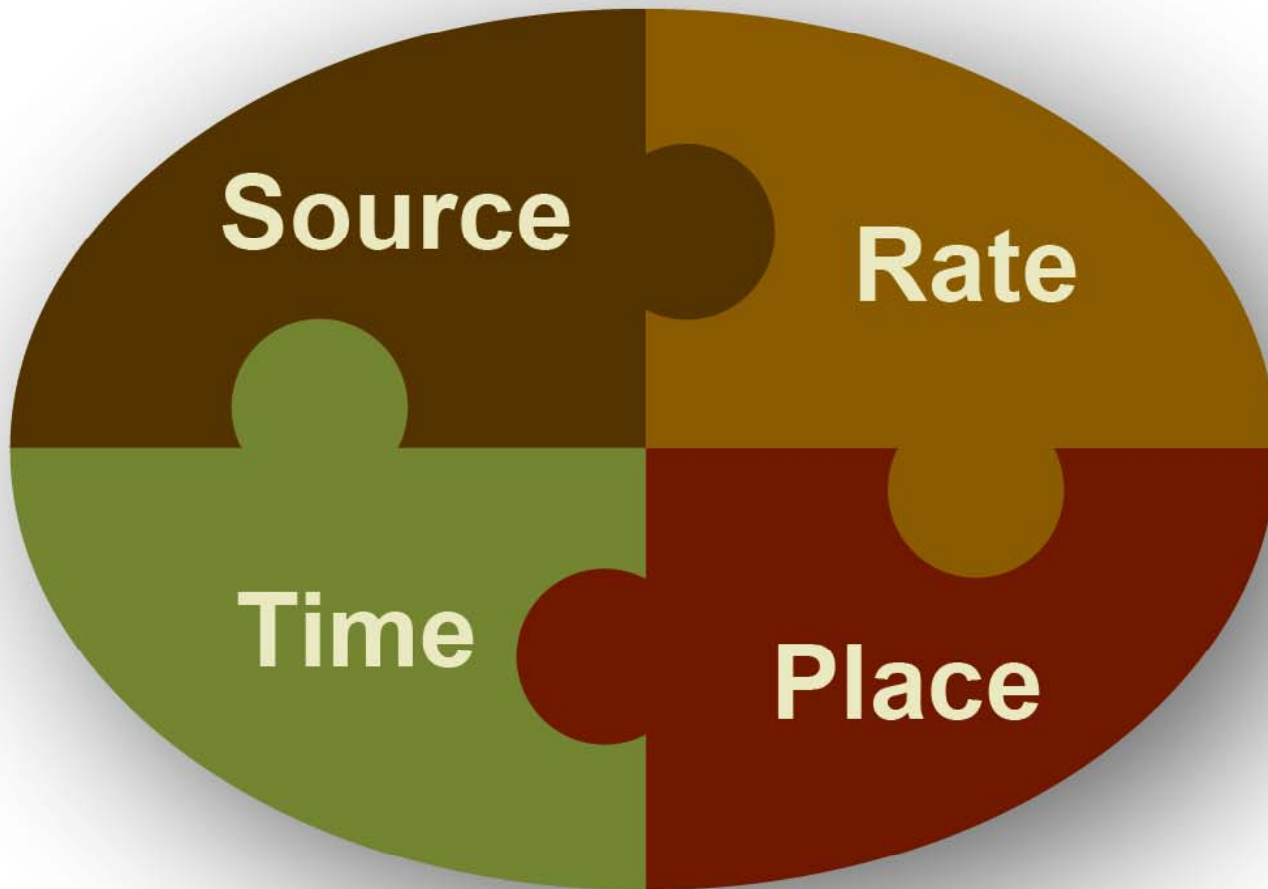


**CCA's required to earn 40 hours
of continuing education (CEU)
every two years**

Some new resources:



4R Nutrient Stewardship: Simple to grasp... continuous improvement



The new database: Search options



The screenshot displays the website for the California Department of Food and Agriculture (CDFA) Inspection Services Division. The header includes the CDFA logo and navigation links: CDFA Home, Inspection Home, Programs, Apply/Register, Laws & Regs, Meetings, and Contact Us. A banner image shows a person in a field with the text "20 years OF FREP RESEARCH". Below the banner, the breadcrumb trail reads "CDFA Home > Inspection Services > FREP Database". The main content area features a search bar with the following options: Keyword(s), Type of Crop, County, and Date Range. A magnifying glass graphic is overlaid on the search bar, highlighting the search options. To the right of the search bar, there is a grid of nine thumbnail images representing various agricultural products and research topics, including pomegranates, avocados, cherries, and various crops.

Keyword(s)

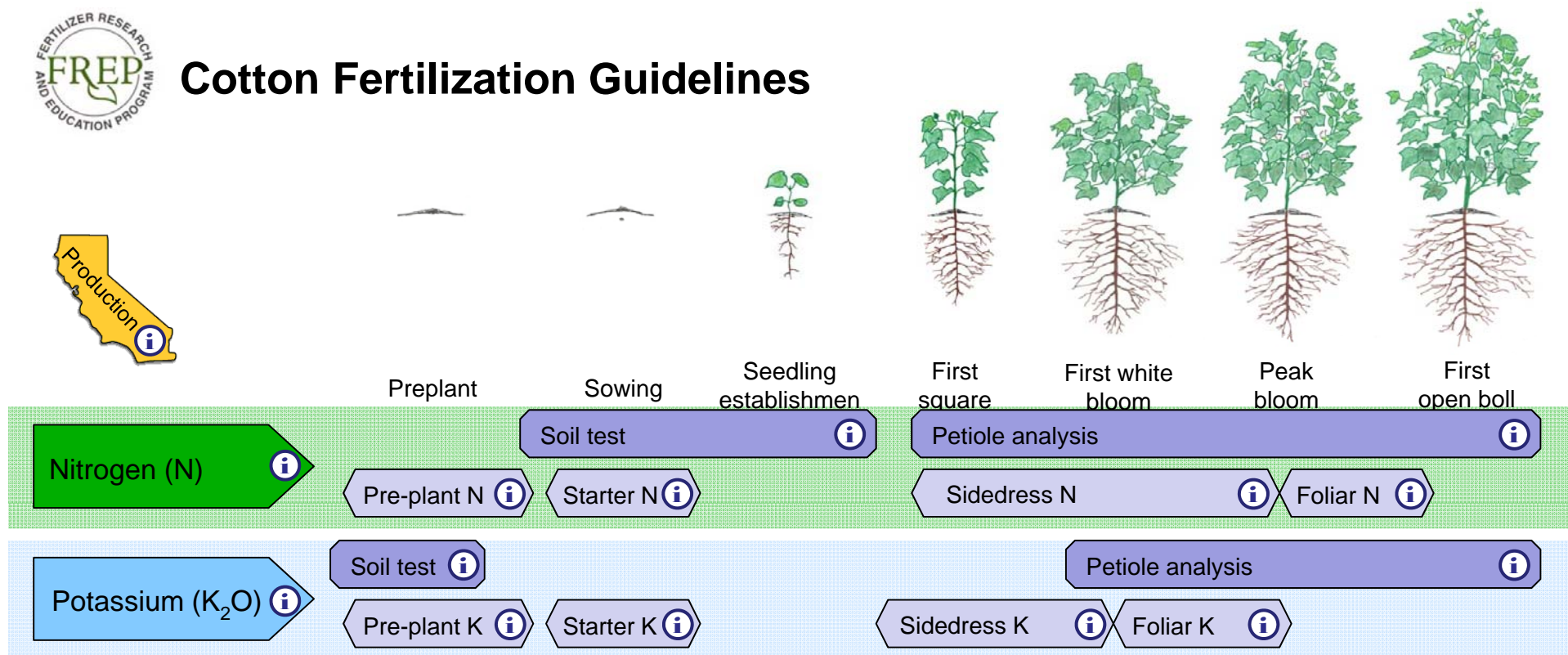
Type of Crop

County

Date Range



Cotton Fertilization Guidelines



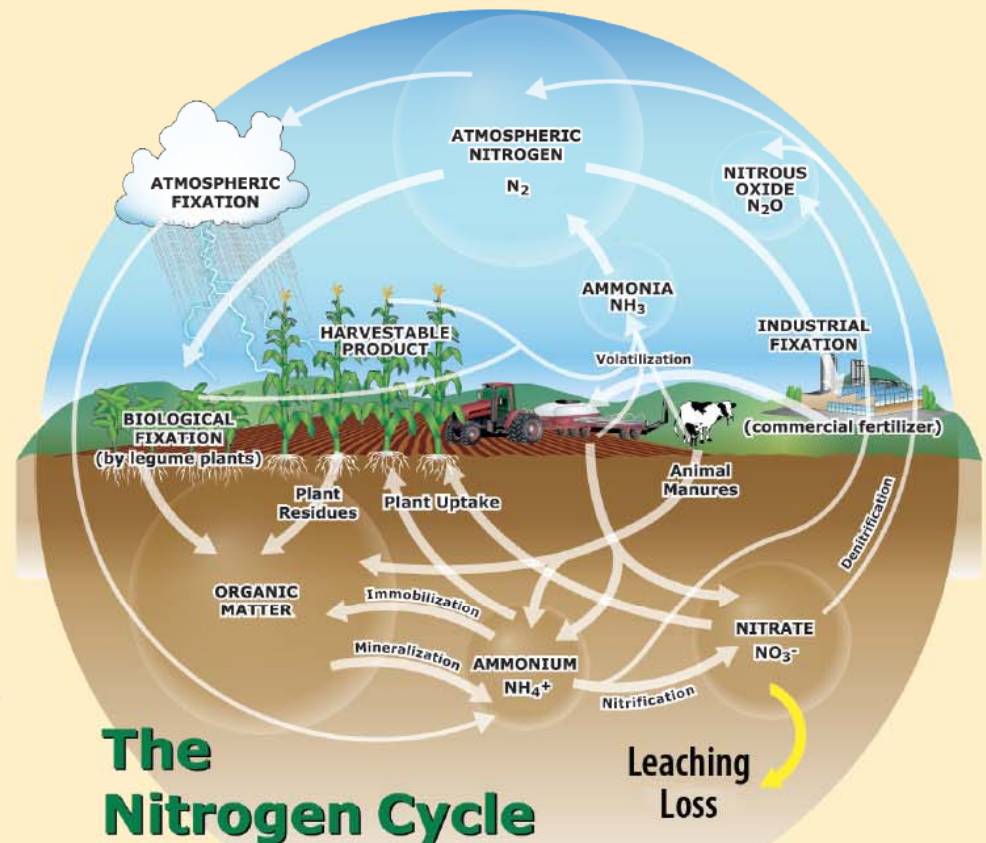
List of references

Links:

- University of California Cotton Production Information
- National Cotton Council of America
- The Cotton Pickin' Web
- California Cotton Ginners and Growers Associations (CCGGA)

NITRATE LEACHING

Nitrate is critical for supporting plant growth, but it is vulnerable to leaching through soil. For nitrate leaching to occur, (1) nitrate must be present in the soil, (2) the soil must be permeable for water movement, and (3) water must be moving through the soil.

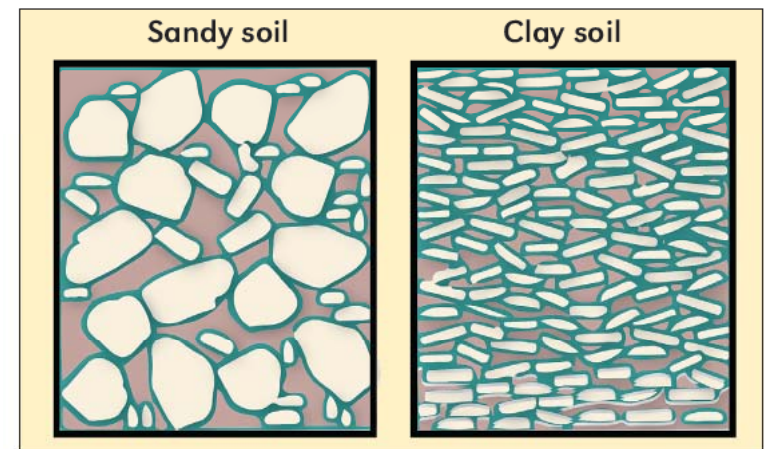


Soil texture? Soil tillage?

Nitrifying bacteria in greatest number near the soil surface.... numbers drop off fast with depth



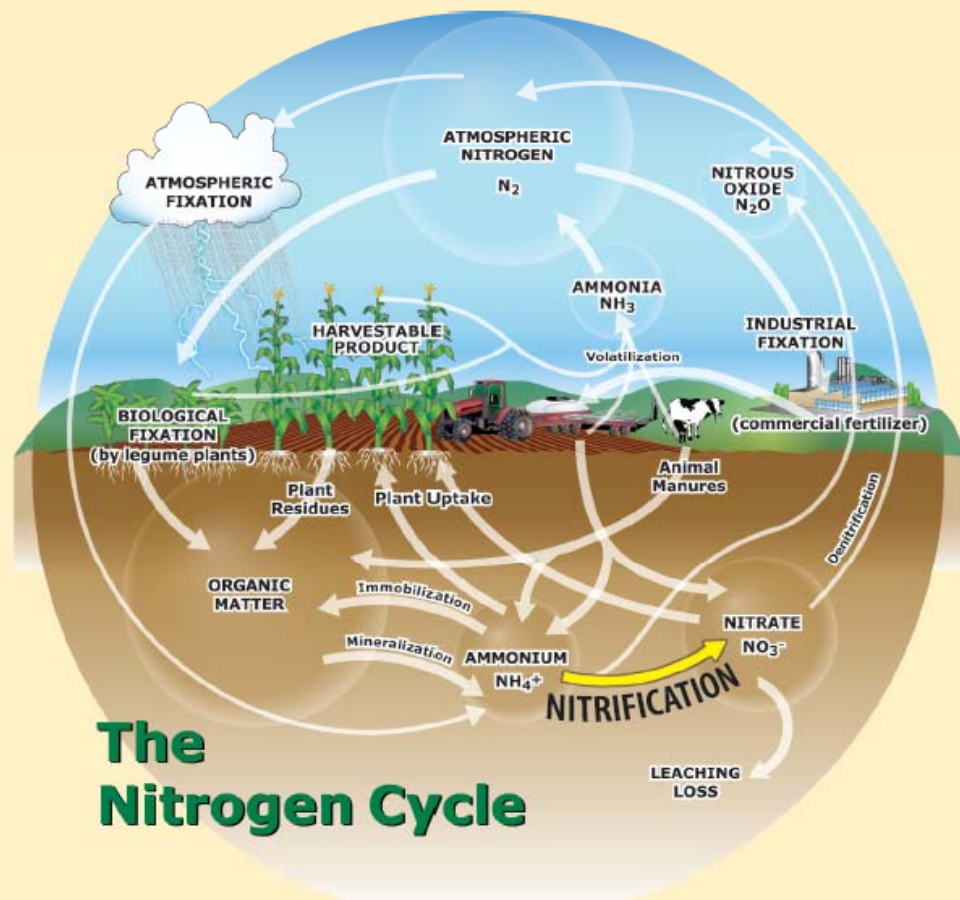
Clay content... higher CEC retains more NH_4^+
... provides more surface area and micropore space for bacteria attachment



Tillage practices affect soil organic matter, aggregation, microbe ecology
(no till usually faster nitrification... air, water?)

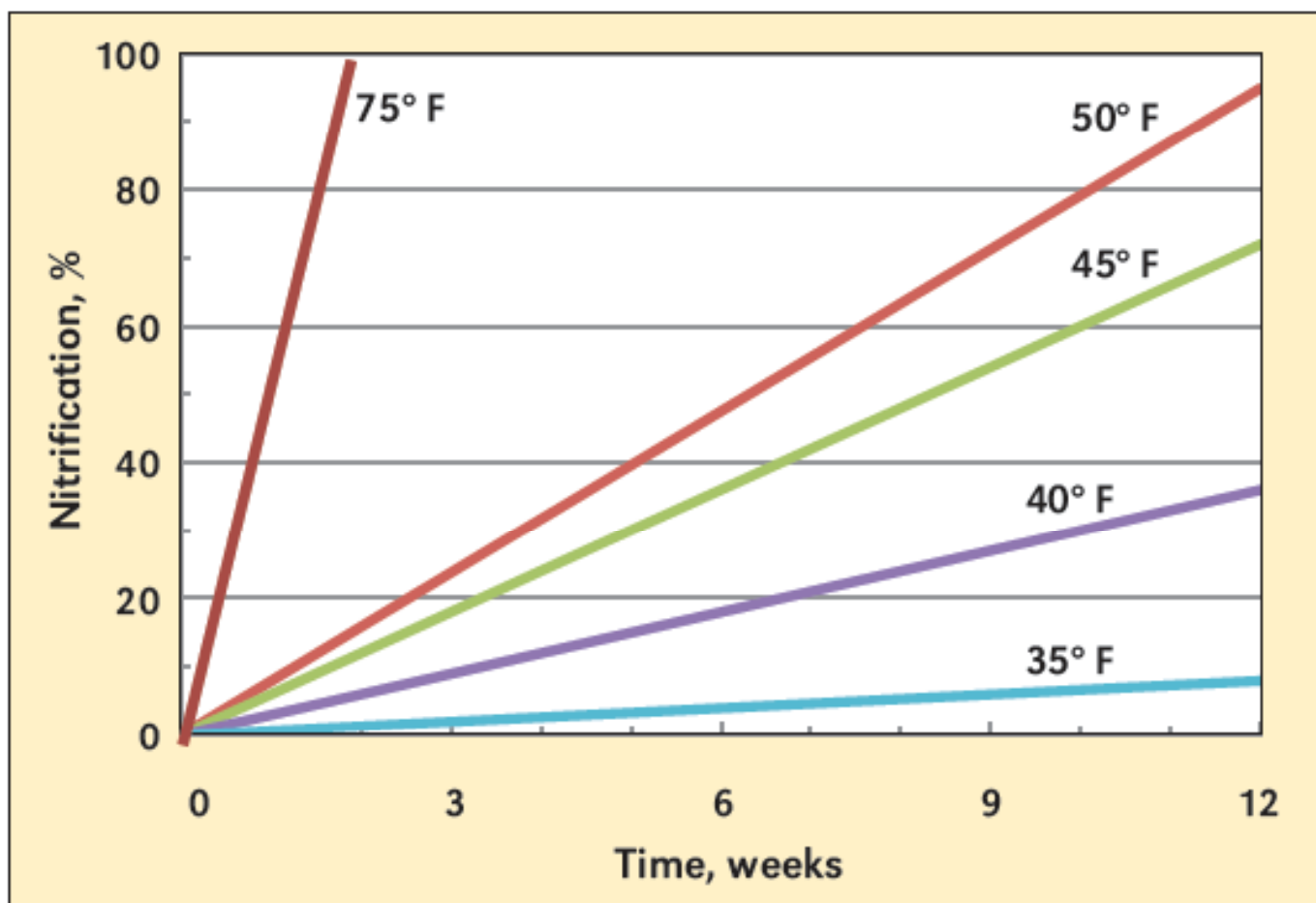
NITRIFICATION

Nitrification is a two-step conversion of ammonium (NH_4^+) to nitrate (NO_3^-) by soil bacteria. In most soils, it is a fairly rapid process, generally occurring within days or weeks following application of a source of ammonium.



Nitrification: How Fast?

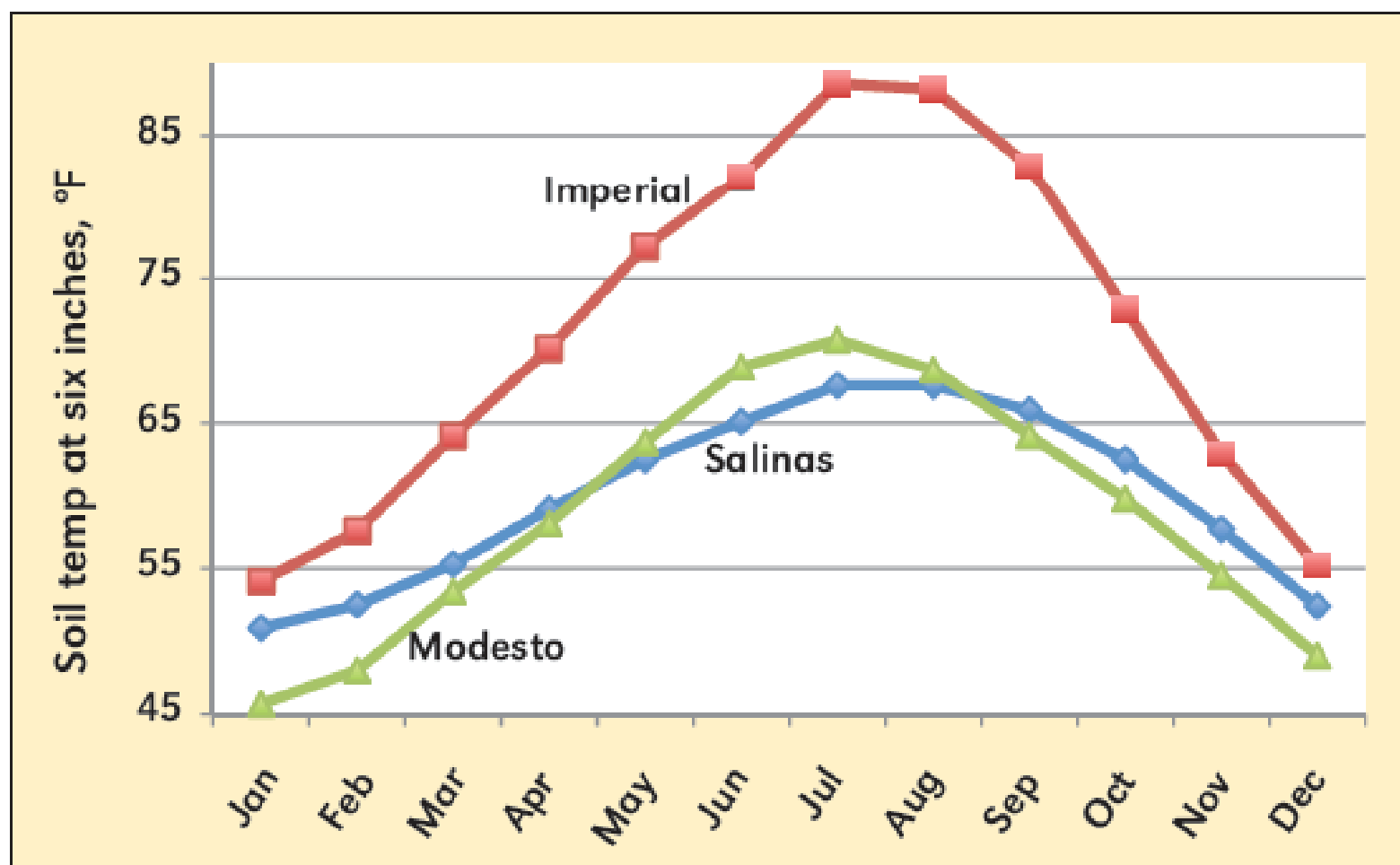
Soil temperature

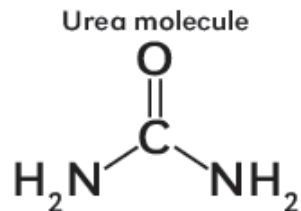


Western Fertilizer
Handbook, 2012



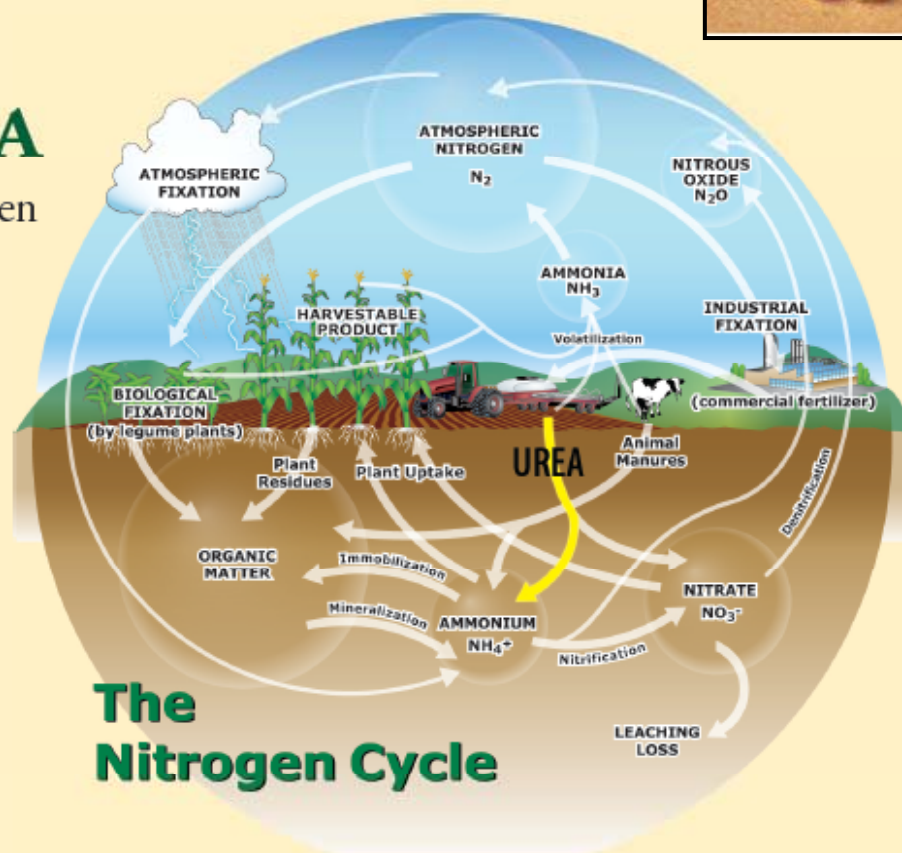
How cold are California soils?



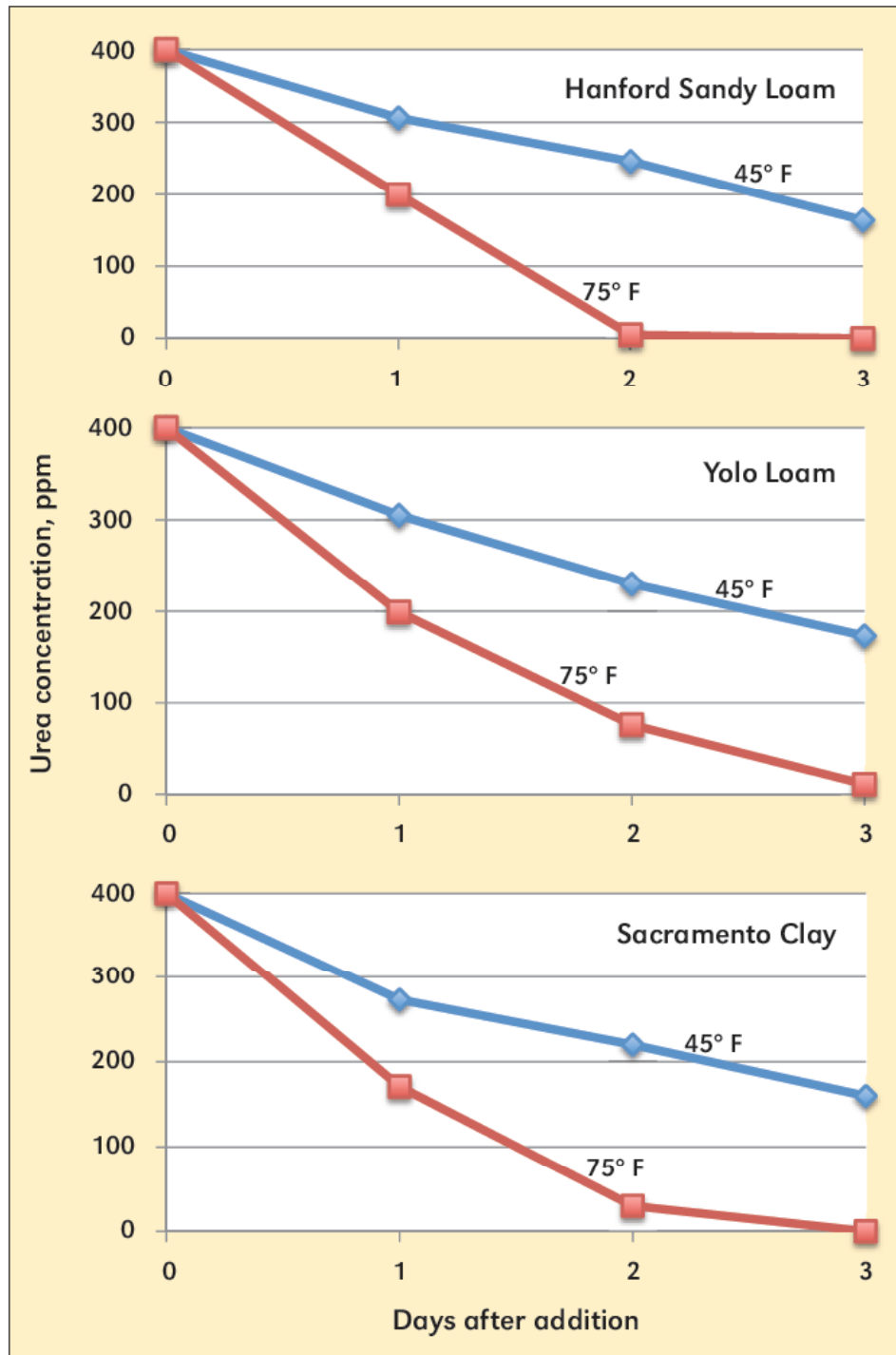


MANAGING UREA

Urea is the most widely used solid nitrogen (N) fertilizer in the world. Urea is also commonly found in nature since it is excreted in the urine of mammals. The high N content of urea (46% N) makes it efficient to transport to farms and apply to fields. Understanding its behavior is important for getting the maximum benefit from this important plant nutrient.



How fast is urea hydrolyzed?



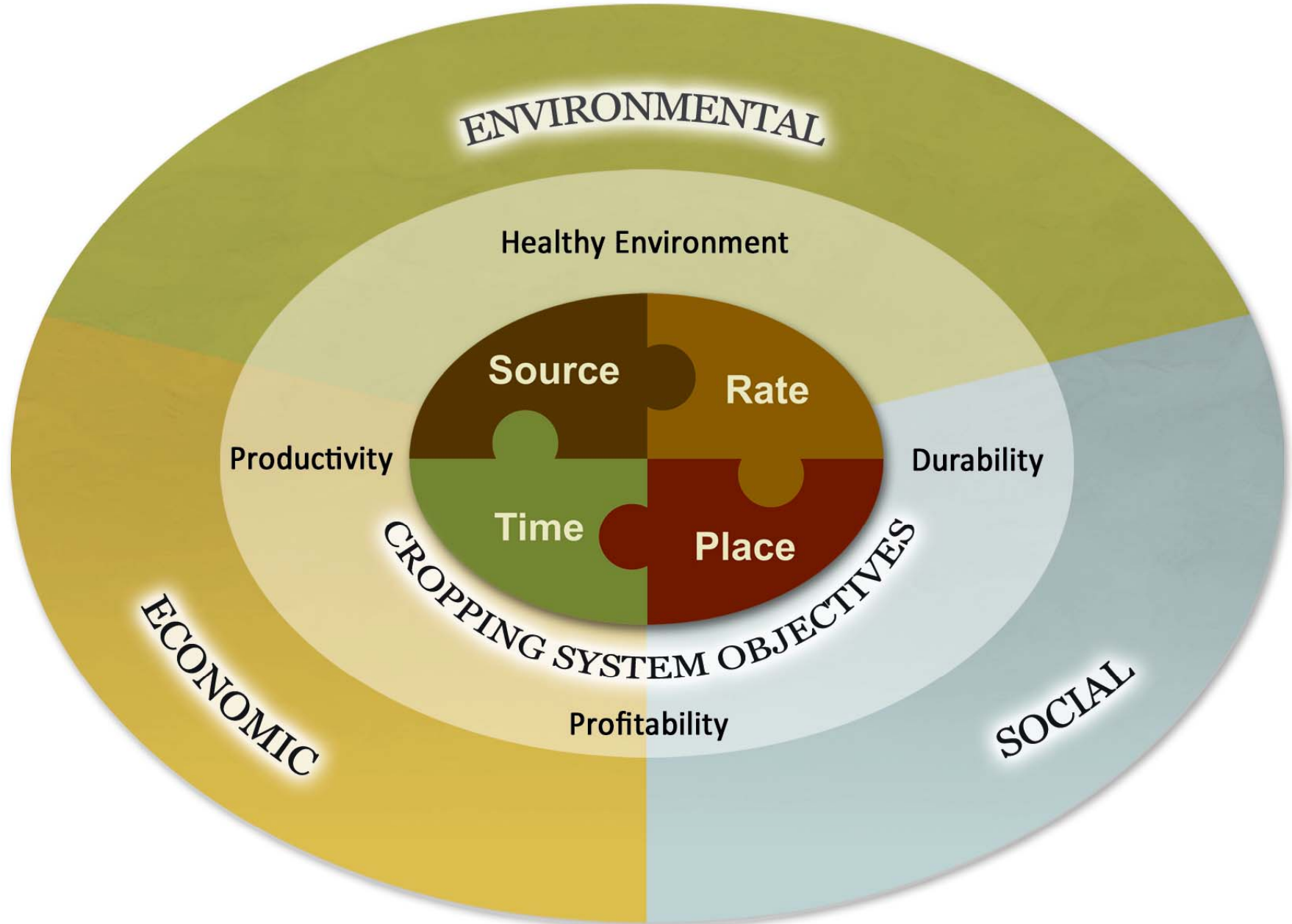
Broadbent et al., 1958

Next in the Nitrogen Management Series:

Applying 4R principles to meet the Nitrogen Demand of Major California Crops

- Almond
- Broccoli
- Citrus
- Corn
- Lettuce
- Rice
- Tomatoes
- Walnut
- Tomatoes





4R technologies and practices



Right Source

Scientific Principle:

- Ensure a balanced supply of plant-available forms of N, utilizing all available sources.

Practices:

- Credit N from manures and composts, irrigation water
- Credit N from previous crops
- Assess use of enhanced-efficiency sources?
 - Granular versus fluid
 - Inhibitors of urease and nitrification
 - Coated fertilizers



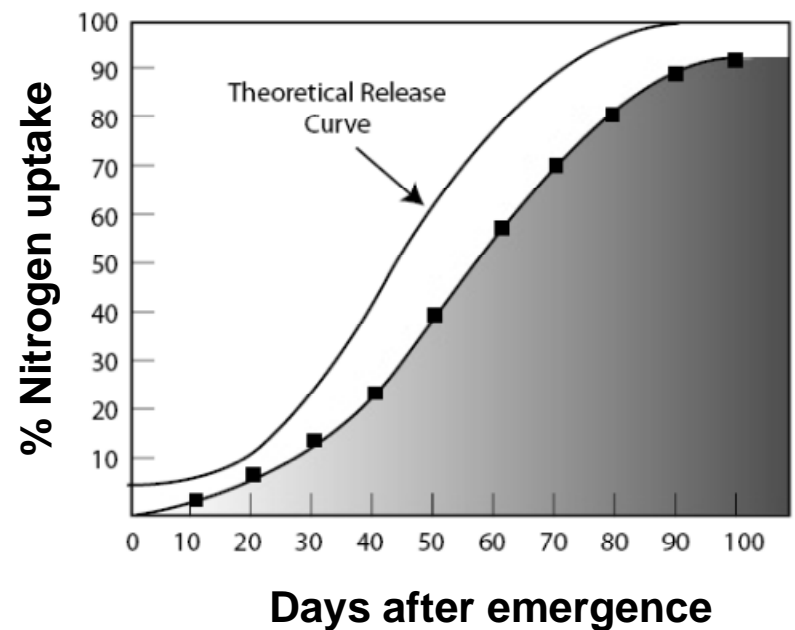
Right Time

Scientific Principle:

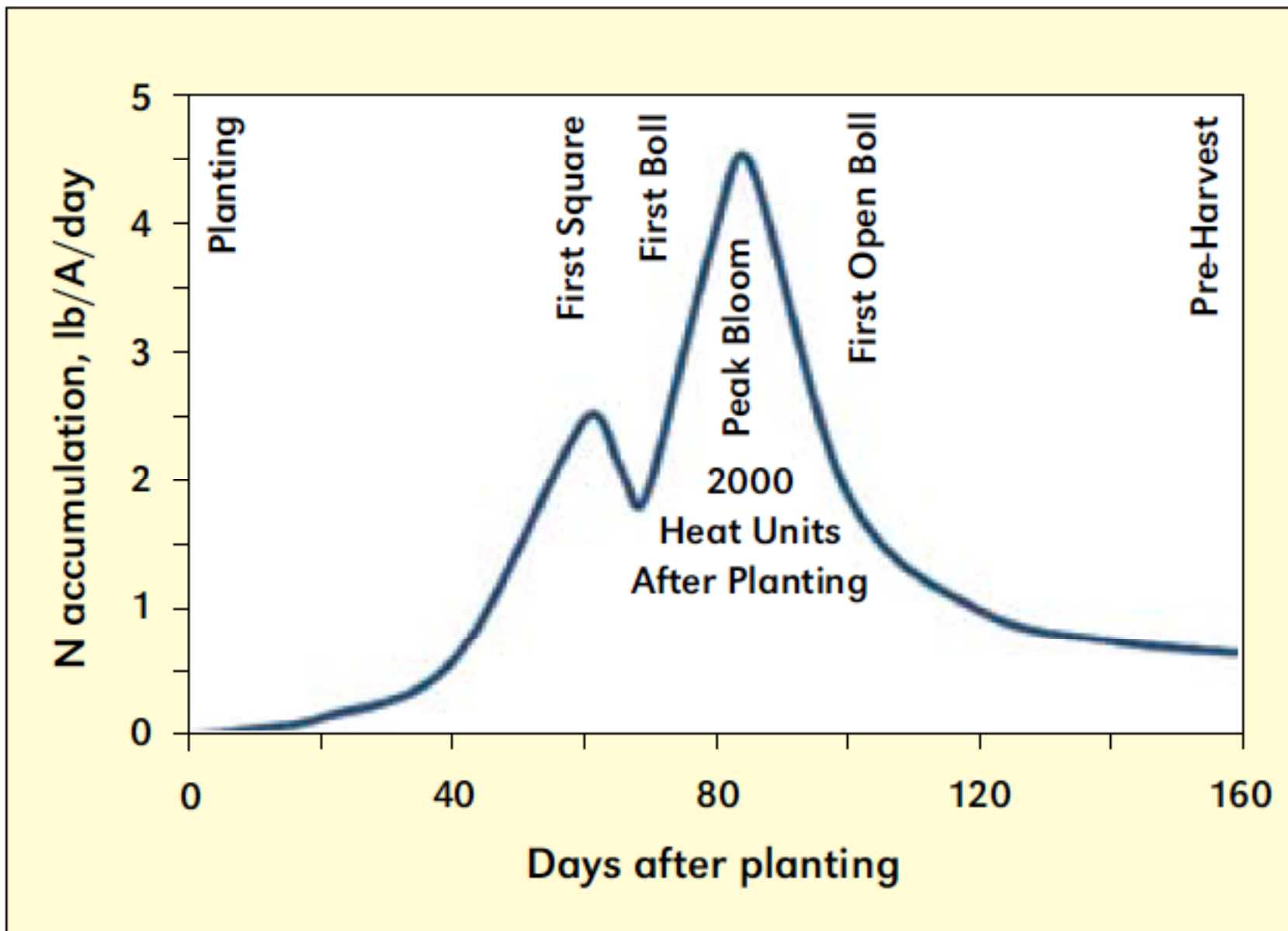
- Assess timing of crop uptake, soil nutrient supply, weather, loss risks and field operation logistics.

Practices:

- Split-application when possible
- Integrate with irrigation
- Cover crops to capture nutrients
- Suit tillage and planting operation

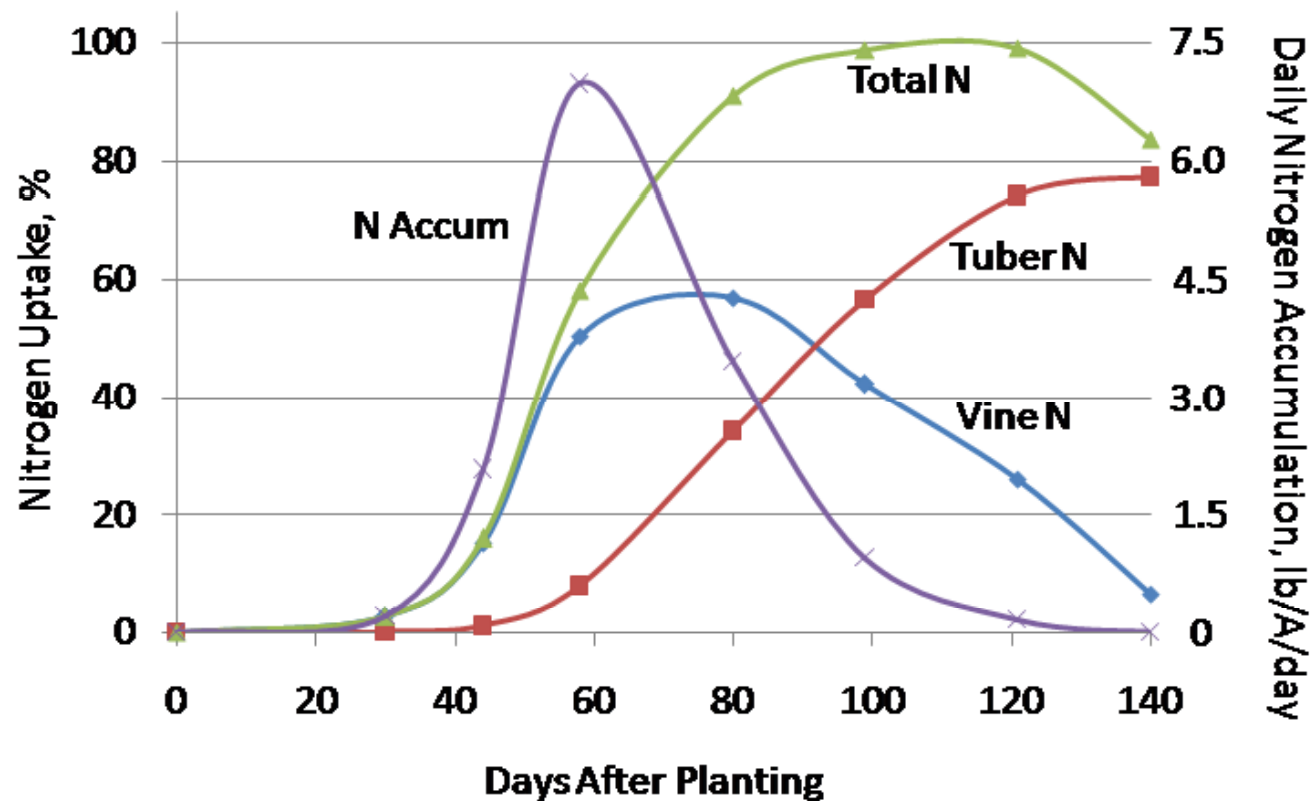


Daily N accumulation for irrigated cotton (Silvertooth, 2011)

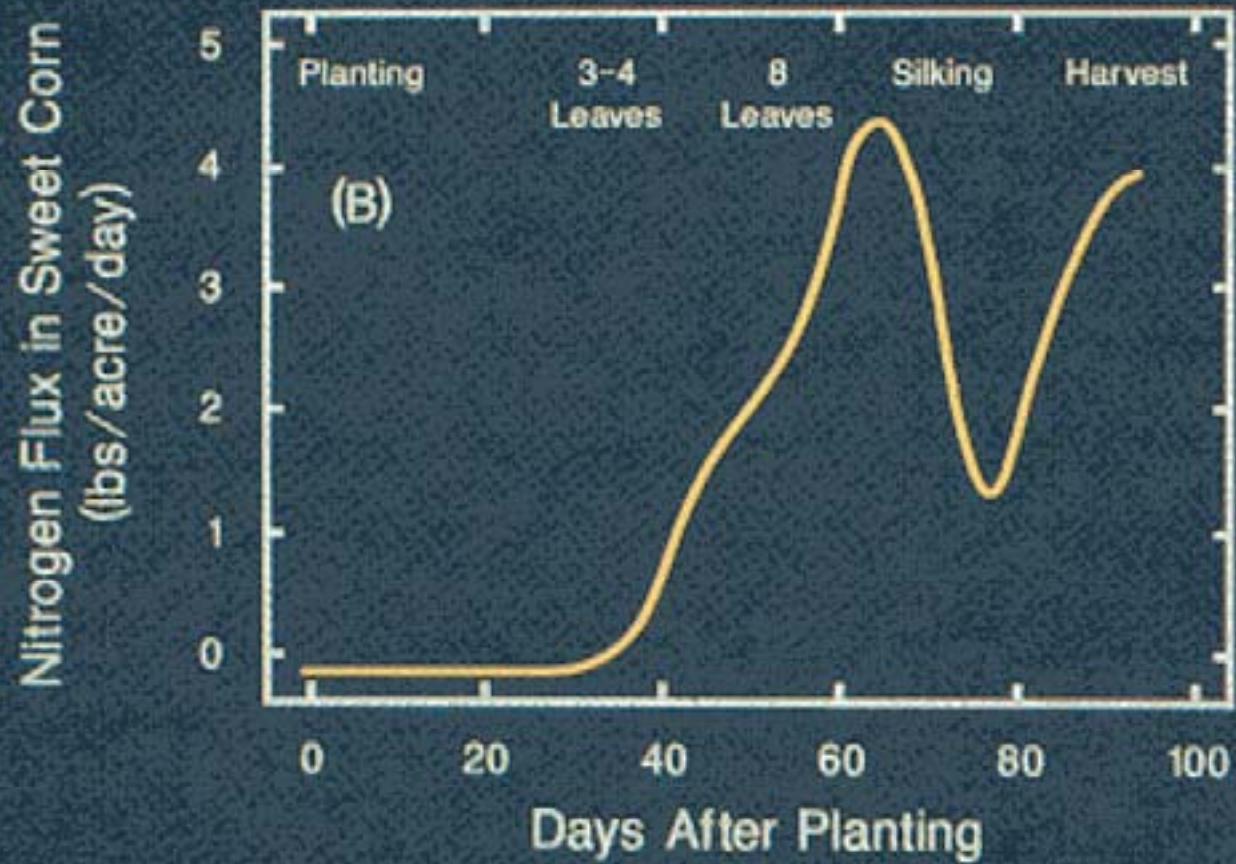


Daily accumulation rates and plant parts

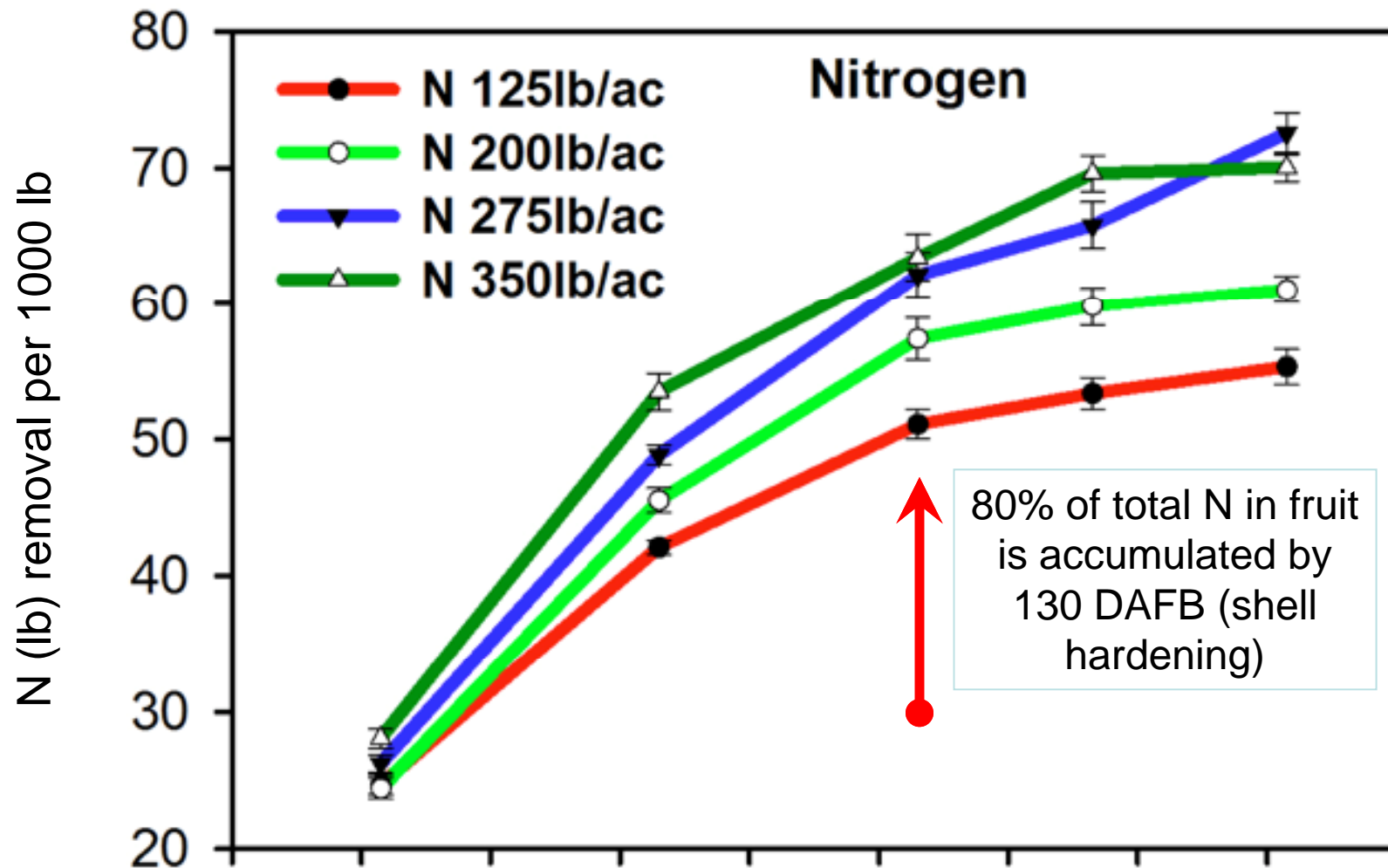
(Russet Burbank potatoes, Oregon)



Daily N uptake: Sweet Corn

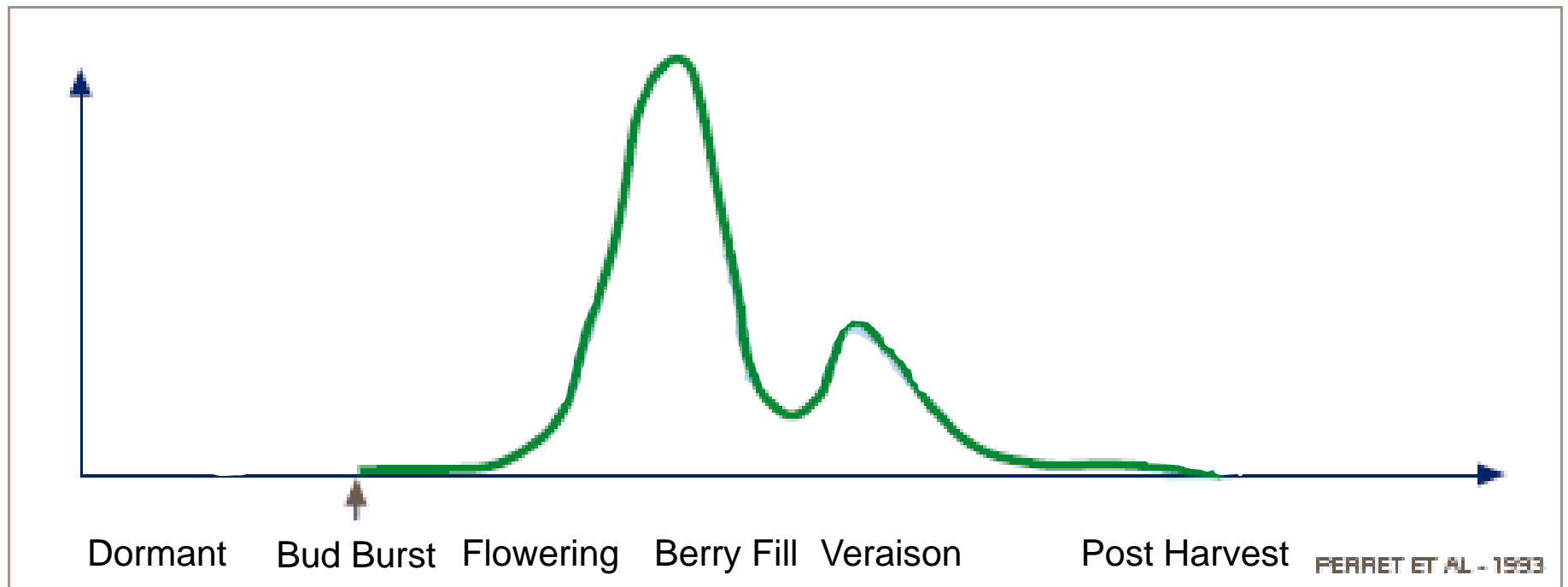


Nutrient Demand is Determined by Almond Yield



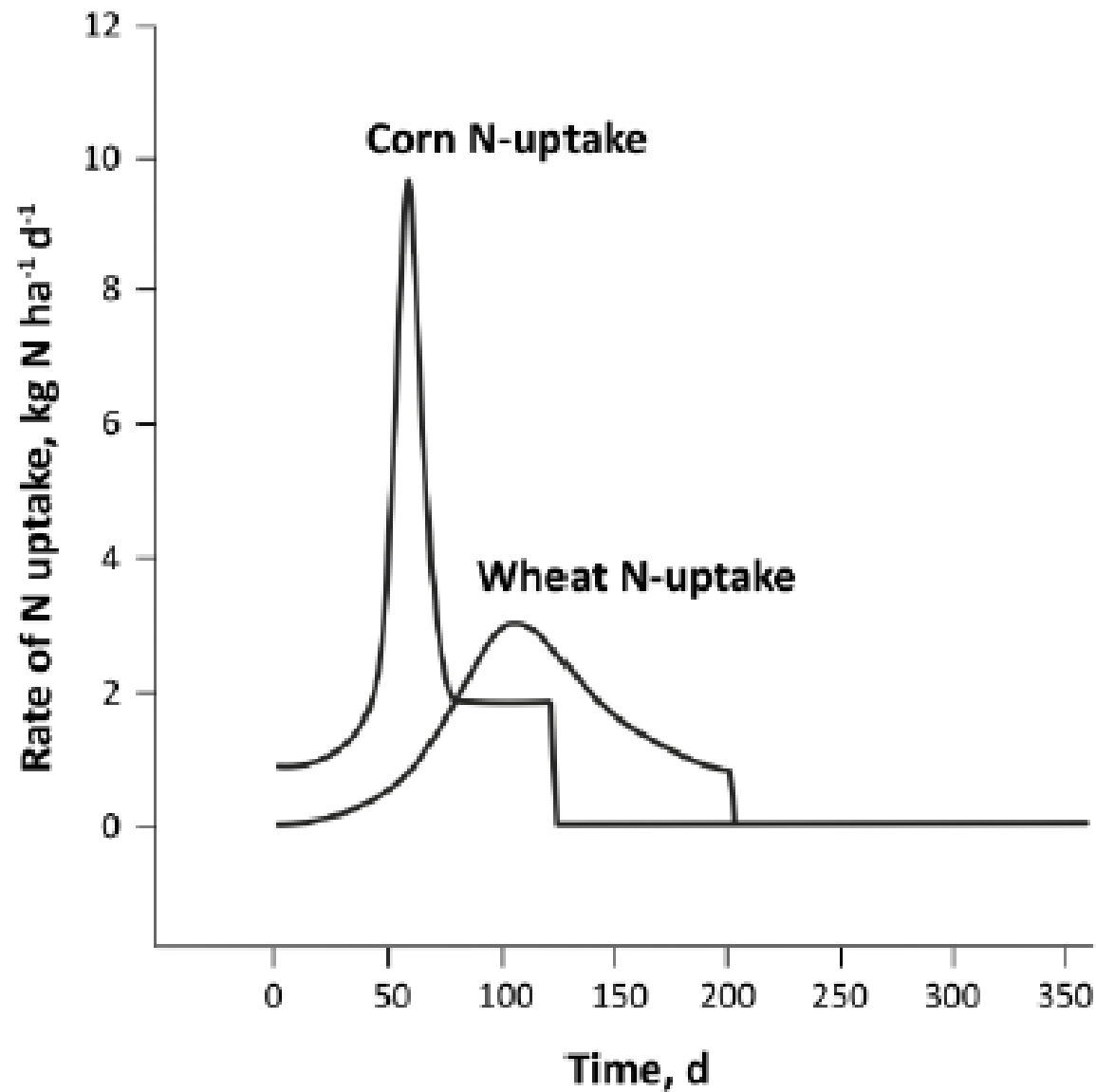
Grape Phenology & Nutrient Uptake

General Nitrogen Requirement of Grapevine



YARA

Contrasting Nitrogen Uptake Curves



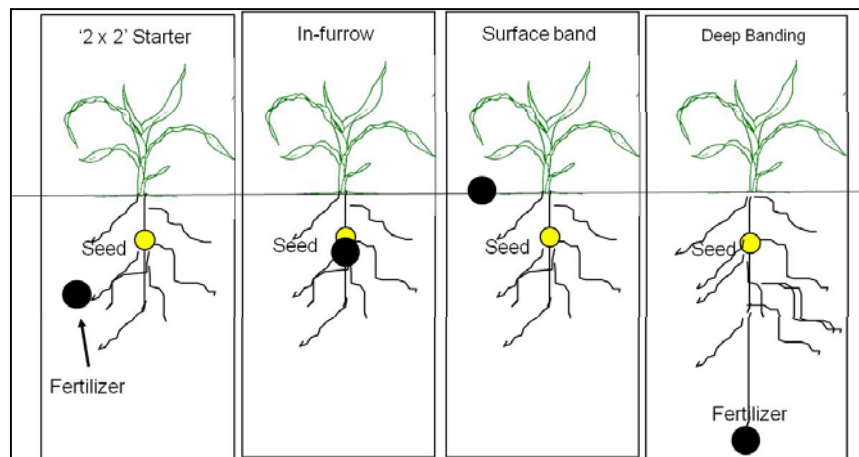
Right Place

Scientific Principle:

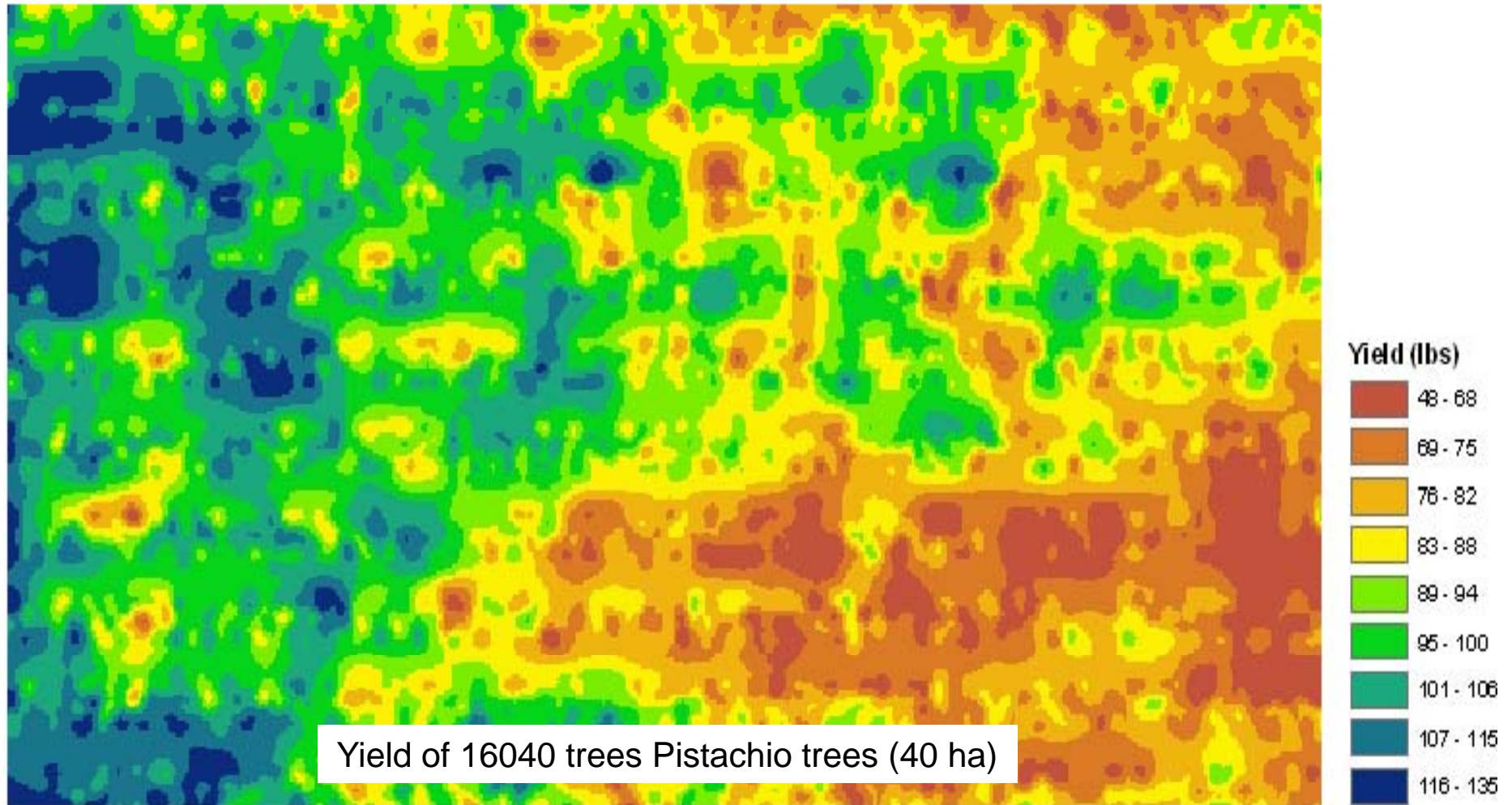
- Place nutrients where they are accessible to the crop.

Practices:

- Site-specific sensing technologies
- Starter placement near seedlings



Uniform Applications of Fertilizers. Non-Uniform Demand. Within Field



0 500 1,000

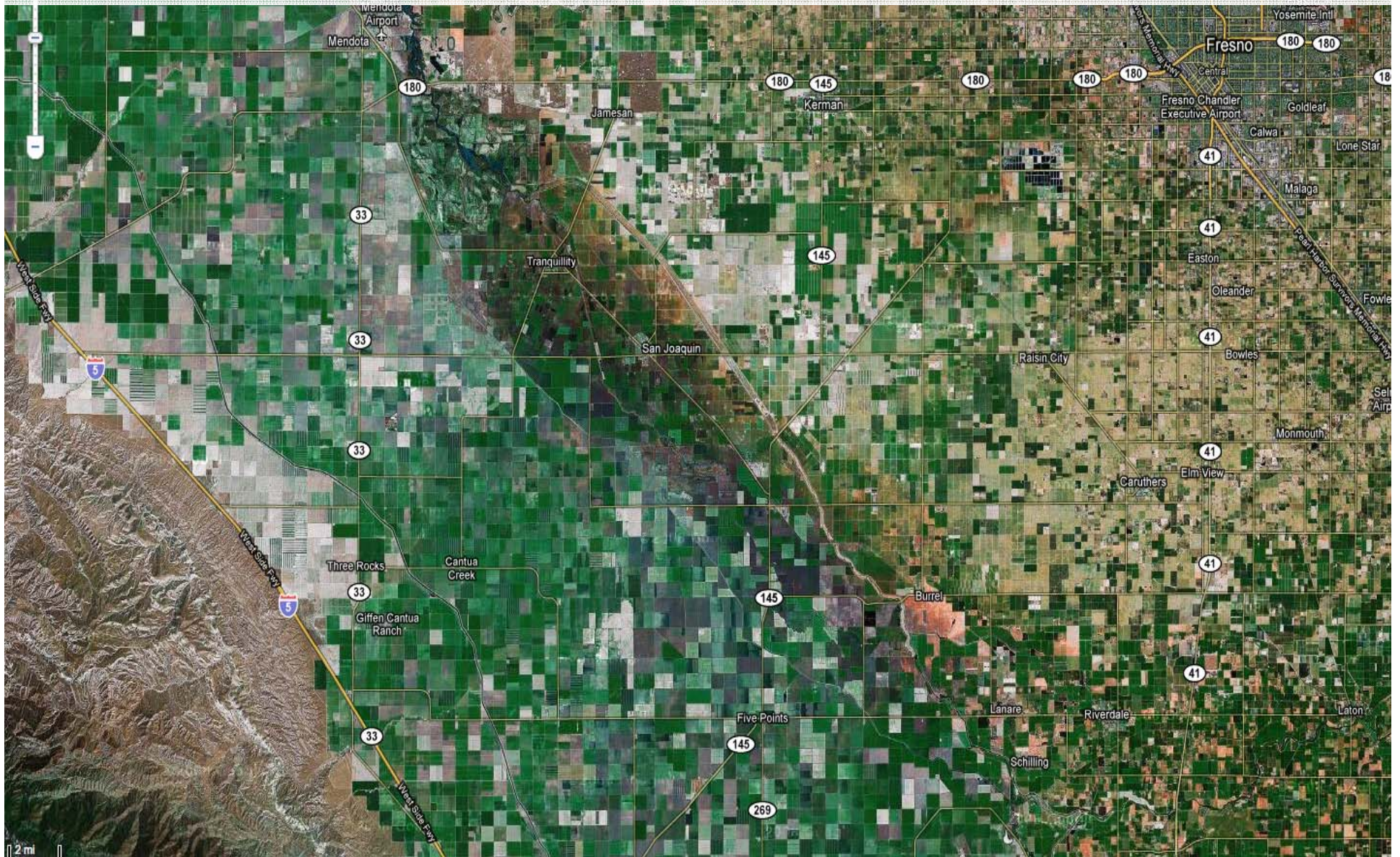
Feet

Pistachio Yield

UCD Patented Tree Yield Monitor (Brown, Rosa)



Large Scale Spatial Variability



Nitrogen Management – Rate Alone?



The “4R” strategy

Right Source at
Right Rate
Right Time
Right Place

For the crop, field or field zone, and nutrient

Right Rate



Scientific Principle:

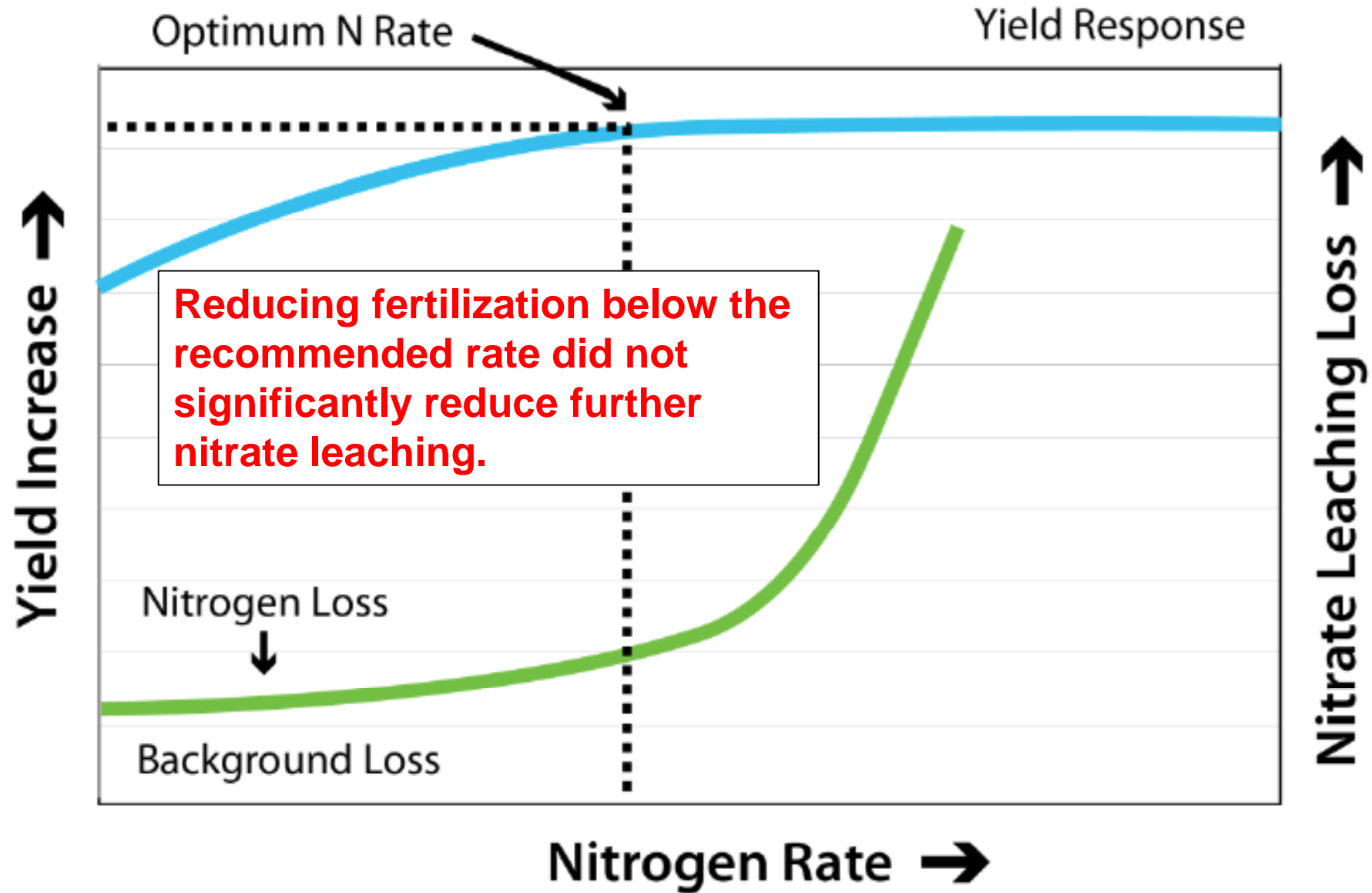
- Assess soil nutrient supply and plant demand for N.

Practices:

- Soil testing
- Tissue analysis
- Balance crop removal
- Determine crop yield potential
- Assess price ratios
- Weather (Adapt-N tool; Cornell)



Relationship between N inputs, crop response, and nitrate loss



Overcoming Barriers to BMP Adoption/ What

Economic - Cost of BMP implementation, market risk for yield and quality
What is the optimal rate for each field? What is affordable?

Environmental - Farm and field suitability for BMP's
Do my management practices impact water quality?

Agronomic: Applying the right amount, right time, right place, right source?
Yield and quality implications

Psychological – Sense of community, resource use, environmental stewardship ethics, human, wildlife, animal health, perceived BMP effectiveness, moral obligation

Social – Community information and advice, civic responsibility
Do neighbors value my efforts for resource stewardship?

Institutional – Confidence in government BMP program effectiveness
How good of a job is needed? Never enough?



Platte River Valley

Example from Nebraska

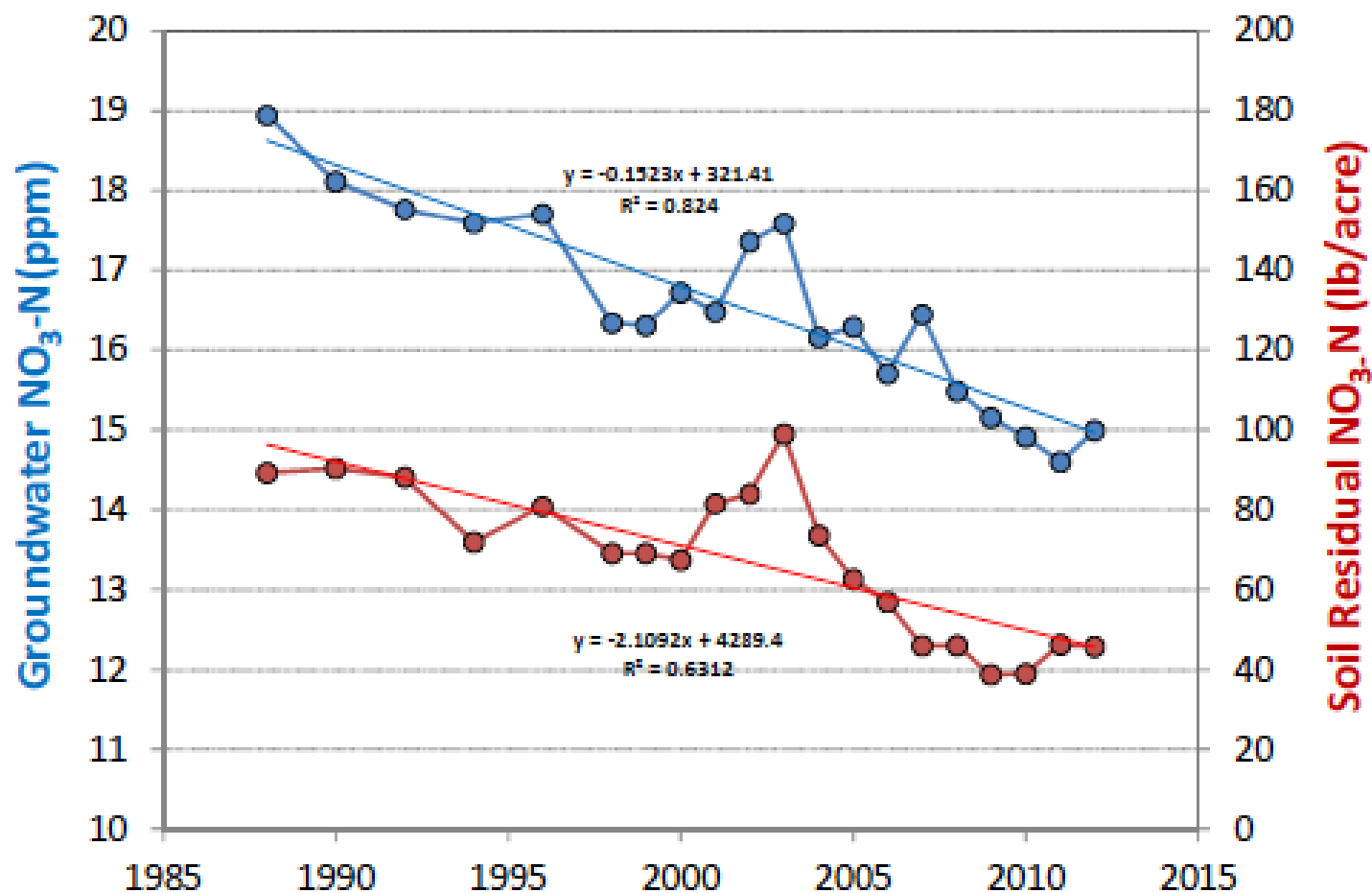
Water and Nitrogen



Nitrogen and water management are directly linked – improved use efficiency of one will likely improve the use efficiency of the other.



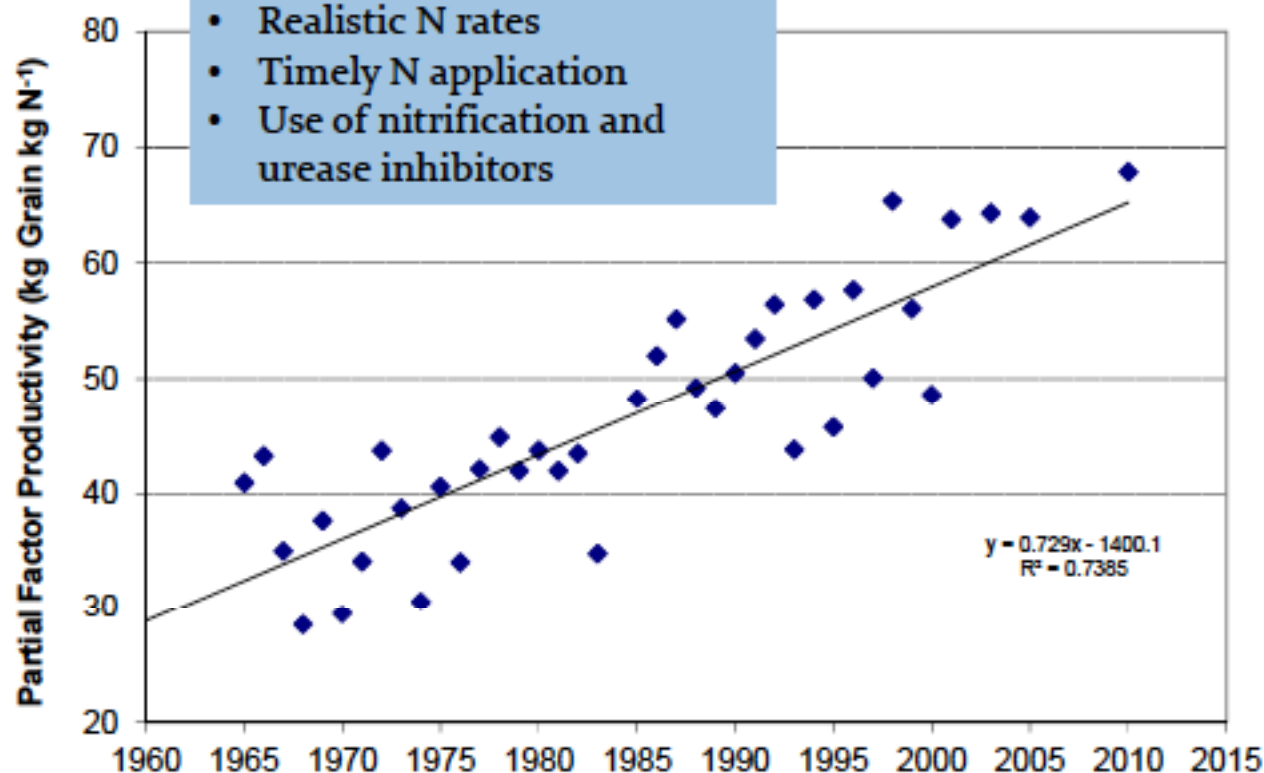
Trends in the Central Platte Valley



Average of values from producer reports in GWMA, representing ~ 300,000 acres

Nitrogen Use Efficiency for Corn in Nebraska

- Improved genetics
- Improved cultural practices
- Realistic N rates
- Timely N application
- Use of nitrification and urease inhibitors



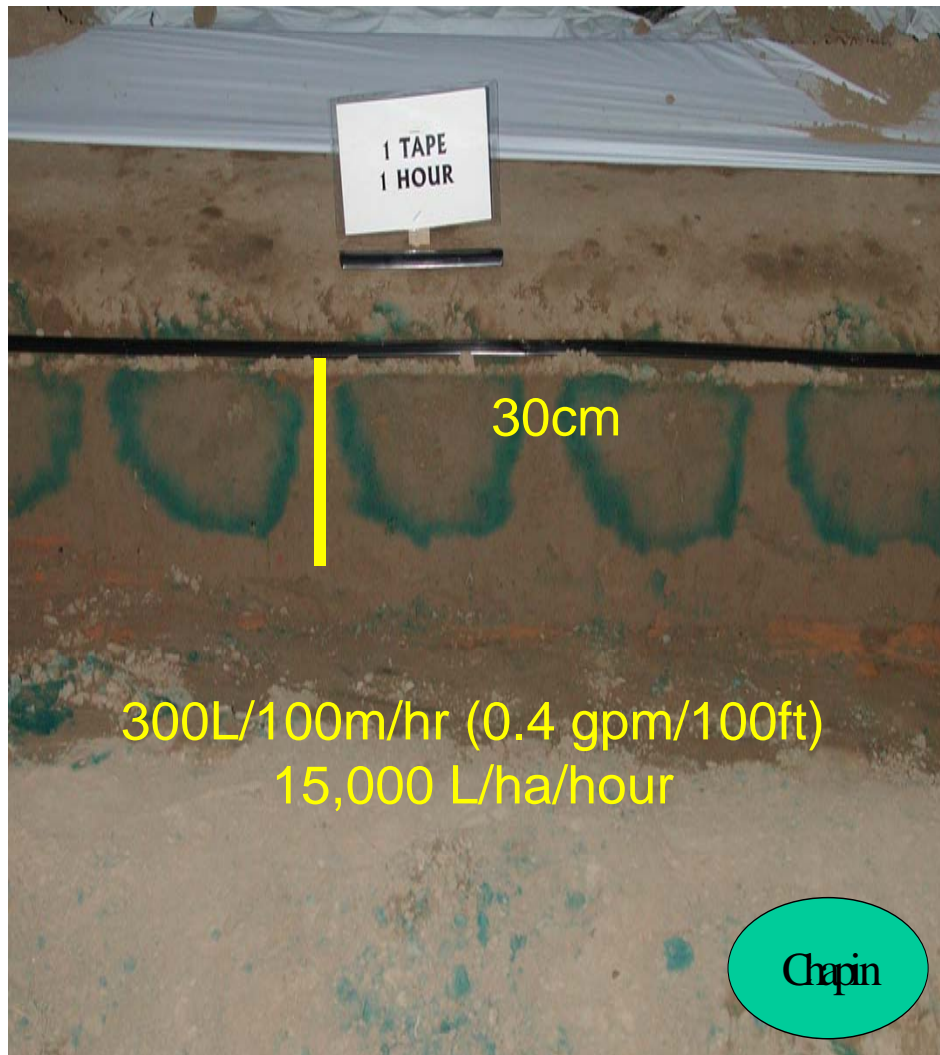
Derived from USDA-NASS ARMS Survey and Nebraska Dept. of Agriculture statistics on nitrogen fertilizer use and corn grain production



Water Management is Key to Nitrogen Management



Water and nutrients must be carefully managed to avoid over-irrigation and poor nutrient application




4R adoption by agricultural industry

Precision nutrient and water management is in!

CPS, Wilbur-Ellis, Simplot, Cargill, ...



nutrientstewardship.com



ABOUT | CALENDAR | FUNDING | PARTNERS | CONTACT

Search...

WHAT ARE THE 4RS | IMPLEMENT THE 4RS | 4R TRAINING

4R CONSISTENT SYSTEMS

These systems are consistent with the 4Rs and can help you create a comprehensive 4R nutrient stewardship plan. [Learn more](#) about what it means for a nutrient management system to be 4R-Consistent.


WILBUR-ELLIS COMPANY
14300 Nicollet Ct., suite 203
Burnsville, MN 55306
ph: 952-898-5562

THE ANDERSONS, INC.
The Andersons, Inc PO Box 119
Maumee, OH 43537
ph: 800-537-3370

SIMPLLOT
999 Main Street, Suite 300
Boise, ID 83702

IMPLEMENT THE 4RS

4R Nutrient Stewardship represents an innovative approach to fertilizer best management practices (BMPs). The 4Rs imply there are four aspects to every fertilizer application and it provides a framework to assess whether a given crop has access to the necessary nutrients. Asking “Was the crop given the right source at the right rate, at the right time, and in the right place?” helps identify opportunities to improve fertilizer efficiency and prevent nutrient movement from each field.

To learn more, please download our brochure:  [Implementing 4R Nutrient Stewardship on the Farm Right Now](#)

This is an example of an unpublished revision.


RIGHT SOURCE


RIGHT RATE


RIGHT TIME


RIGHT PLACE


PARTNERS WITH THE PRODUCTS AND SERVICES YOU NEED TO FOLLOW THIS PART OF YOUR 4R PLAN



 The Fertilizer Institute
Nourish, Replenish, Grow

 CANADIAN FERTILIZER INSTITUTE
INSTITUT CANADIEN DES ENGRAIS

 IPNI
INTERNATIONAL
PLANT NUTRITION
INSTITUTE

 International
Fertilizer Industry
Association

The Fertilizer Institute | 425 Third Street, S.W., Suite 950 | Washington, D.C. 20024 | ph: 202.962.0490 | fax: 202.962.0577
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4R Certification – Lake Erie Watershed

- Rollout 18 March 2014 – 190+ agri-retail audience
- 22 agri-retail locations signed up for audit summer 2014
- Audit procedures from SCS Global

4R Nutrient Stewardship Certification Program Launched



<http://4rcertified.org/>

Who is working on 4R Certification?

**The
Andersons**



AGRIbusiness
Council of
INDIANA



**The
Fertilizer Institute**
Nourish, Replenish, Grow



**The Nature
Conservancy**
Protecting nature. Preserving life.



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INTERNATIONAL
PLANT NUTRITION
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Ohio
AgriBusiness Association

NRCS

**DESHLER FARMERS
ELEVATOR**

**SOY
OHIO**
Ohio Soybean Council
www.soyohio.org



EDF
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Finding the ways that work.

**Nester
Ag**



**MICHIGAN STATE
UNIVERSITY**

**T · H · E
OHIO
STATE
UNIVERSITY**



“4R Inside” Checklist, includes:

- 1. Balance economic, social, environmental areas.**
- 2. Include BMPs addressing S,R,T, & P.**
- 3. Provide site-specific recommendations.**
- 4. Balance essential elements.**
- 5. Assess nutrient requirements.**
- 6. Consider all sources.**
- 7. Comply with regulations.**
- 8. Measure effectiveness of BMPs.**
- 9. Use terminology consistent with 4R standards.**
- 10. Document plans and implementation.**

4R Advocate Winners 2012

FertilizerInstitute



Subscribe

1 video ▾

2012 4R Advocate Winners



Crop Production



1:27 / 9:20



Minnesota: Another Approach

Nitrogen Fertilization and Promotion Team

Tasks include

- **Survey nutrient management practices**
- **Identify, promote, and implement appropriate BMP's**
- **Consider new alternative management tools**
- **Develop educational efforts**
- **Work with farmers to implement recommended BMP's**
- **Field demonstration projects**
- **Survey and evaluate BMP adoption**

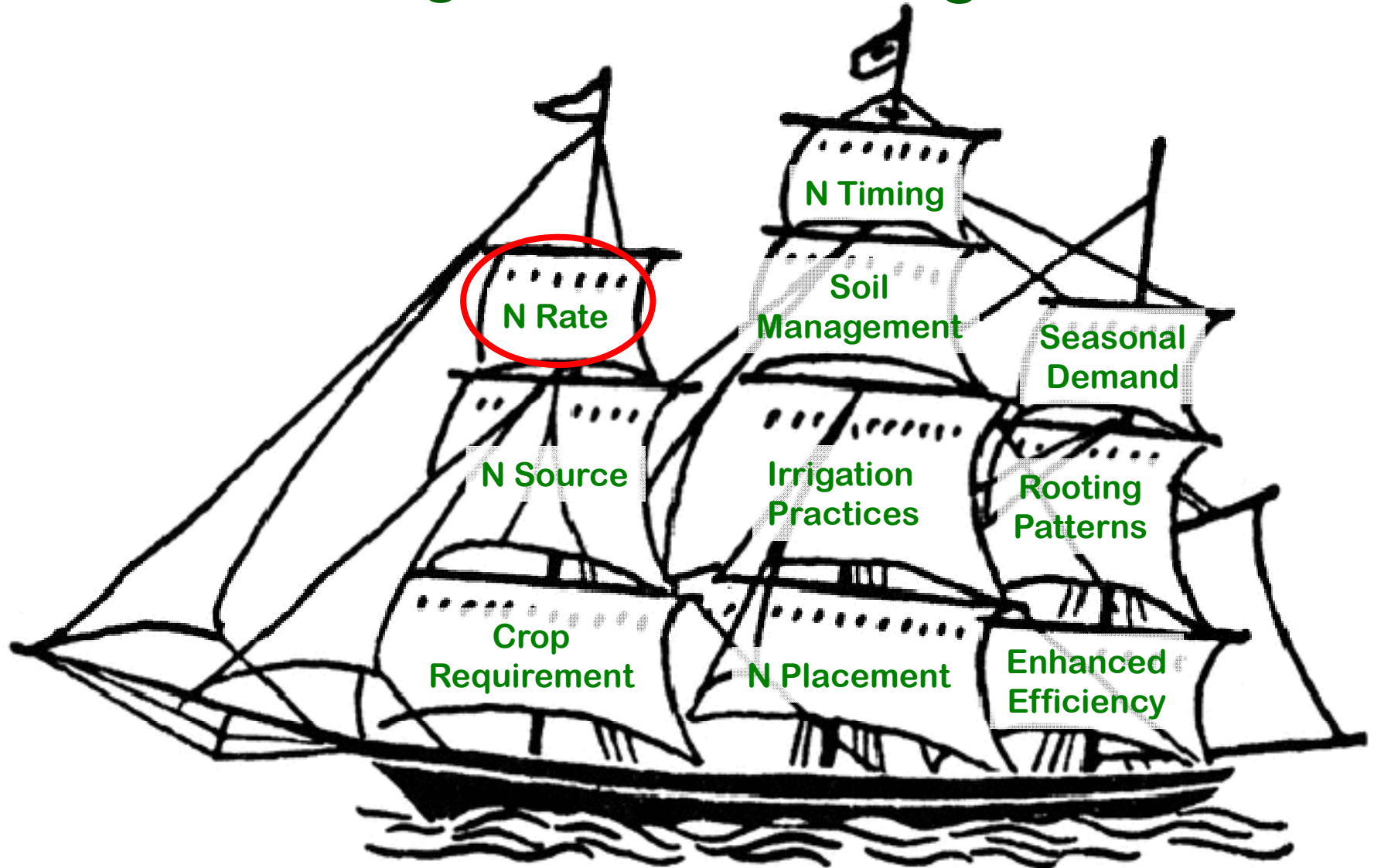
Moving Forward?

Nitrogen budgets: Useful in analysis... but provides no information on environmental impacts. Implemented on a wide variety of scales. Fails to take into account local soil and climatic conditions.

To establish the relationship between the nitrogen balance and leaching, it is necessary to identify environmental characteristics (soil type, climate conditions) and account for land use

Qualitative indicators: useful for locating problem areas. It has been extensively used to analyze the vulnerability of groundwater

Many interacting factors to adjust to get nitrogen fertilization “right”



Yes, we still have a lot to learn, but...

CCA's have the ability to influence the future of California nutrient use...

and help implement improved nutrient stewardship

