IPNI
INTERNATIONAL
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INSTITUTE

4R Nutrient Stewardship for Florida Agriculture

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IFAS/UF In-service training
Gainesville, FL
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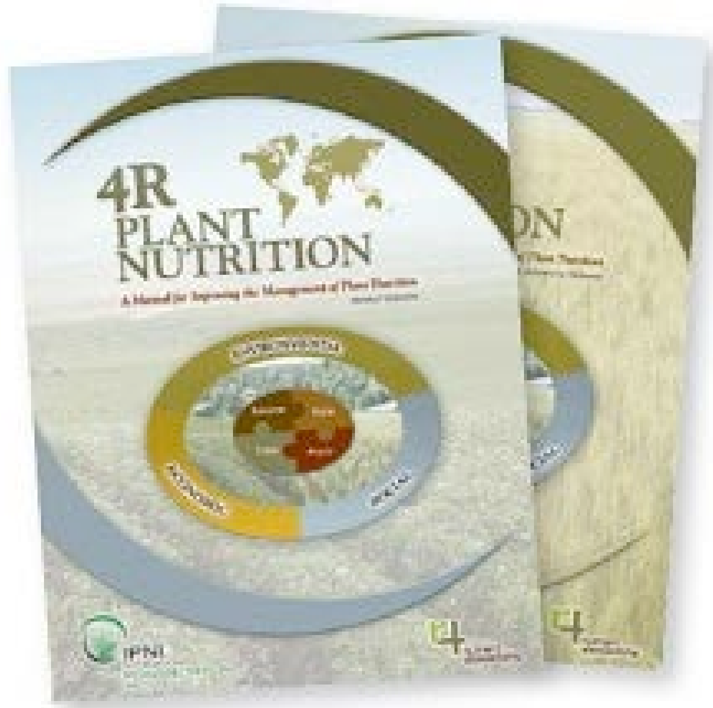
4R Nutrient Stewardship

- **The foundation of fertilizer BMPs and efficient nutrient management can be aptly described as following the "4Rs"…**

  Applying the *Right Source*
  at the *Right Rate* at the
  Right Time
  and in the *Right Place*

  www.IPNI.net/4R



nutrient stewardship

IPNI International Plant Nutrition Institute

Source, rate, time, and place describe any nutrient application

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nutrient stewardship

Equal attention to all 4Rs

- Balance attention to all 4Rs
- Rate: easily overemphasized
- Source, Time, Place: often require major changes and investments

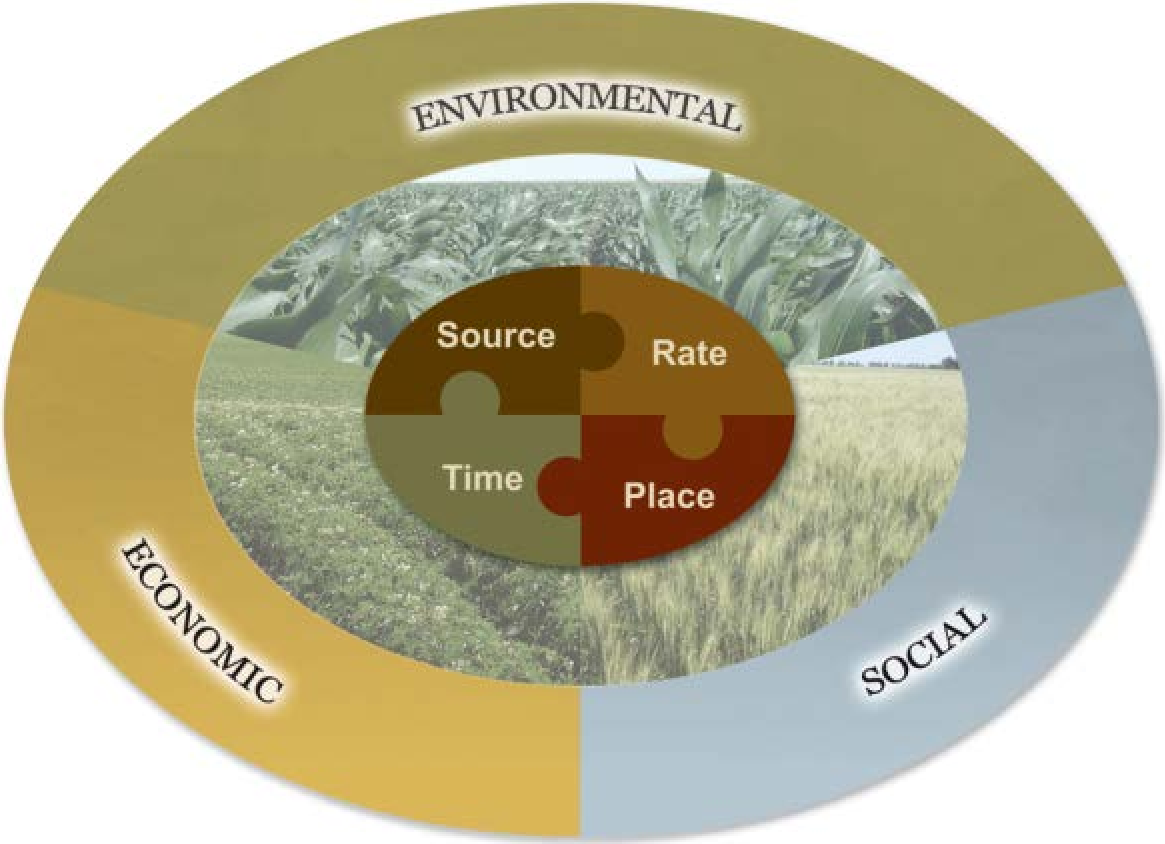
The 4Rs Interconnect

- with each other
- with local soil and climate factors
- with management of soils and crops
- other factors can limit productivity even when levels of plant nutrients are adequate

Right means Sustainable

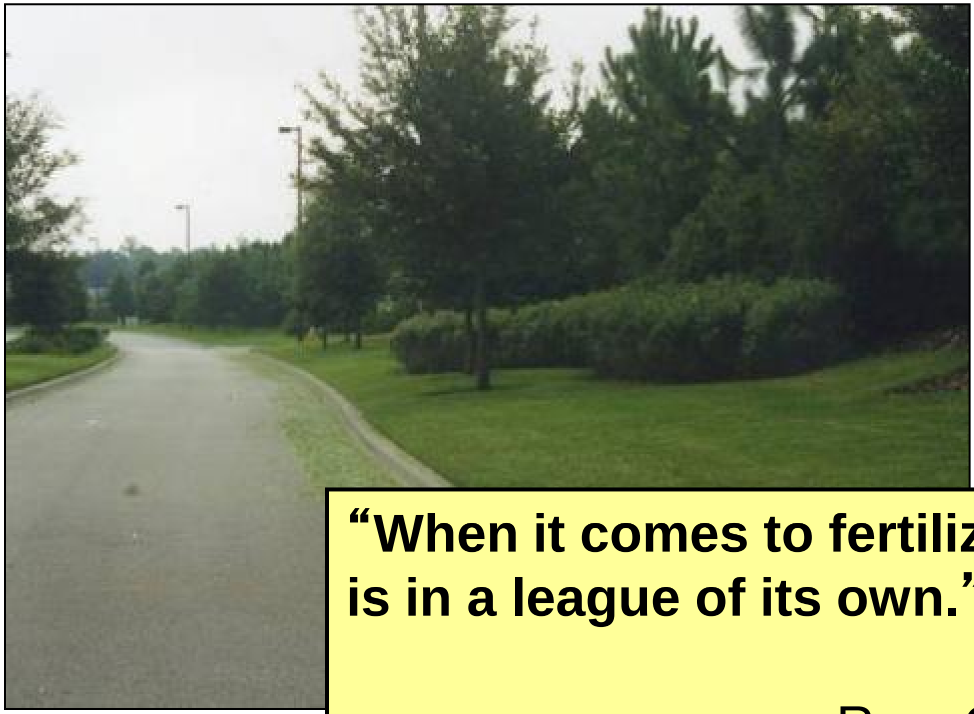
Accommodating the growing demand for production without compromising the natural resources upon which agriculture depends.

- The concept of sustainability is multi-dimensional … applies to social, economic, and environmental simultaneously.



Various crop production systems in Florida

Hochmuth, 2015



"When it comes to fertilizer regulations, Florida is in a league of its own."

Rep. Clay Ingram, R-Pensacola

Urban too!

Hochmuth, 2015

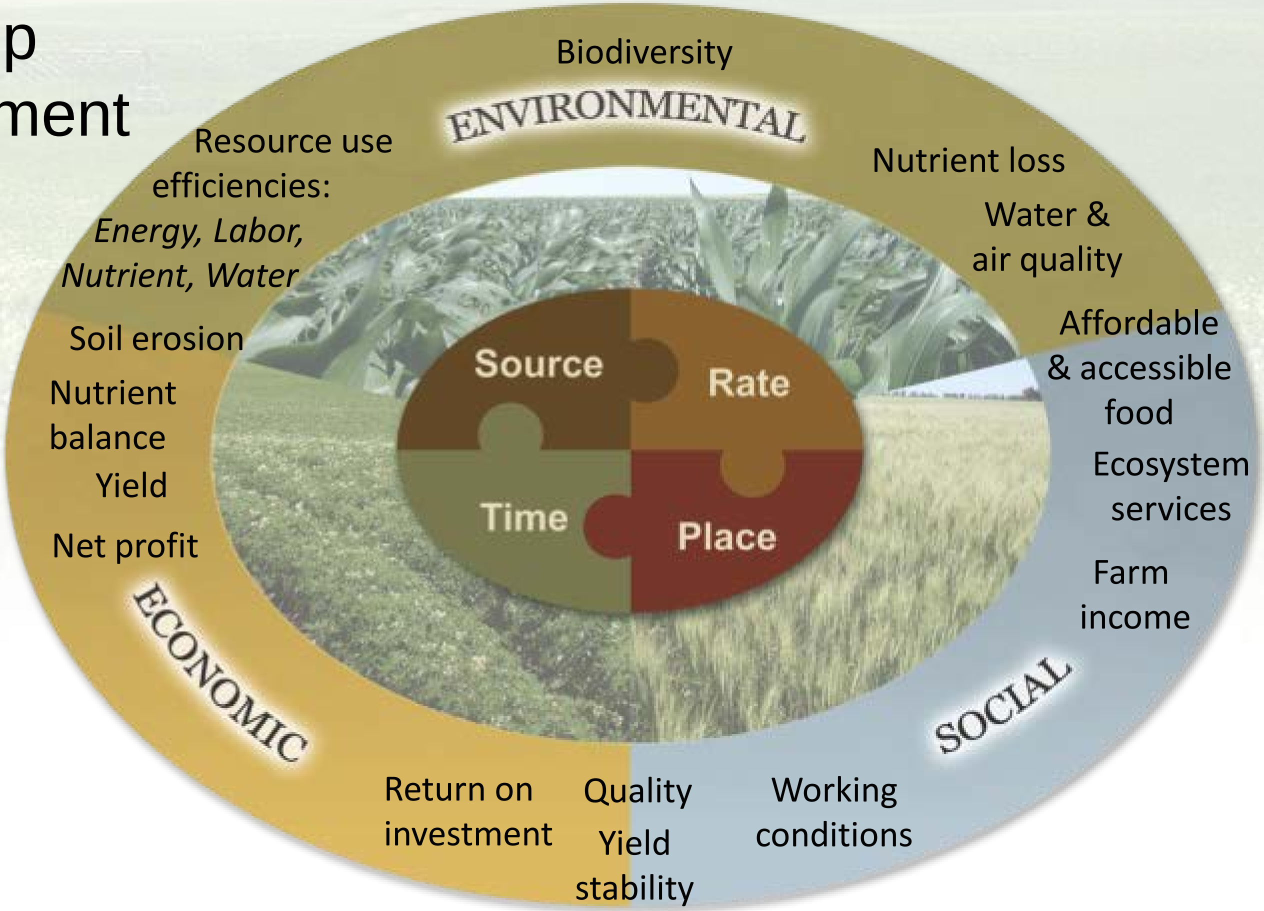
Hochmuth, 2015

Stakeholders have a say on performance indicators

- Stakeholders define goals
- Producers choose practices
- Indicators relate to goals

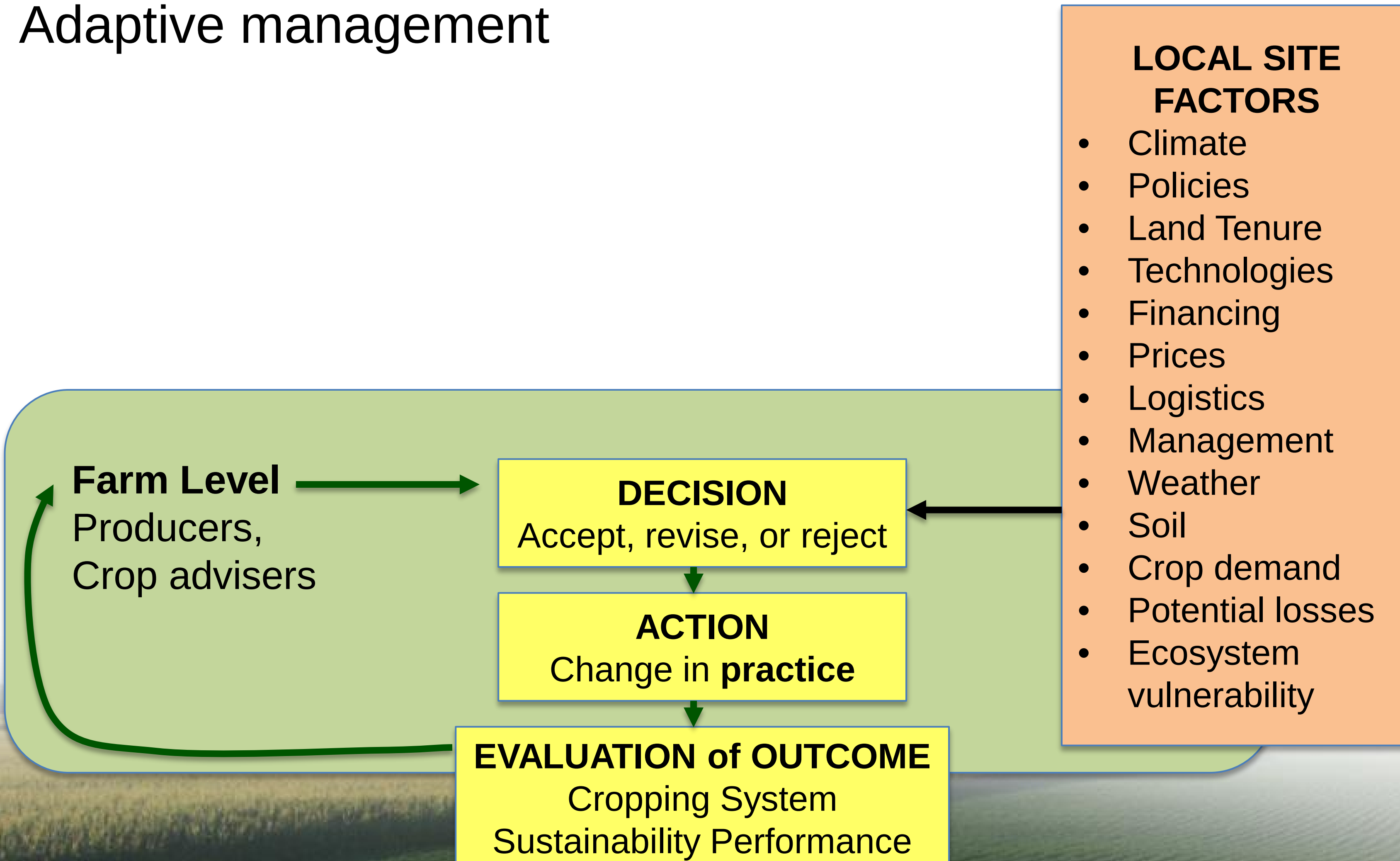
The 4Rs influence many performance indicators

- social, economic and environmental performance
- influenced by crop and soil management as well
- whole system outcomes



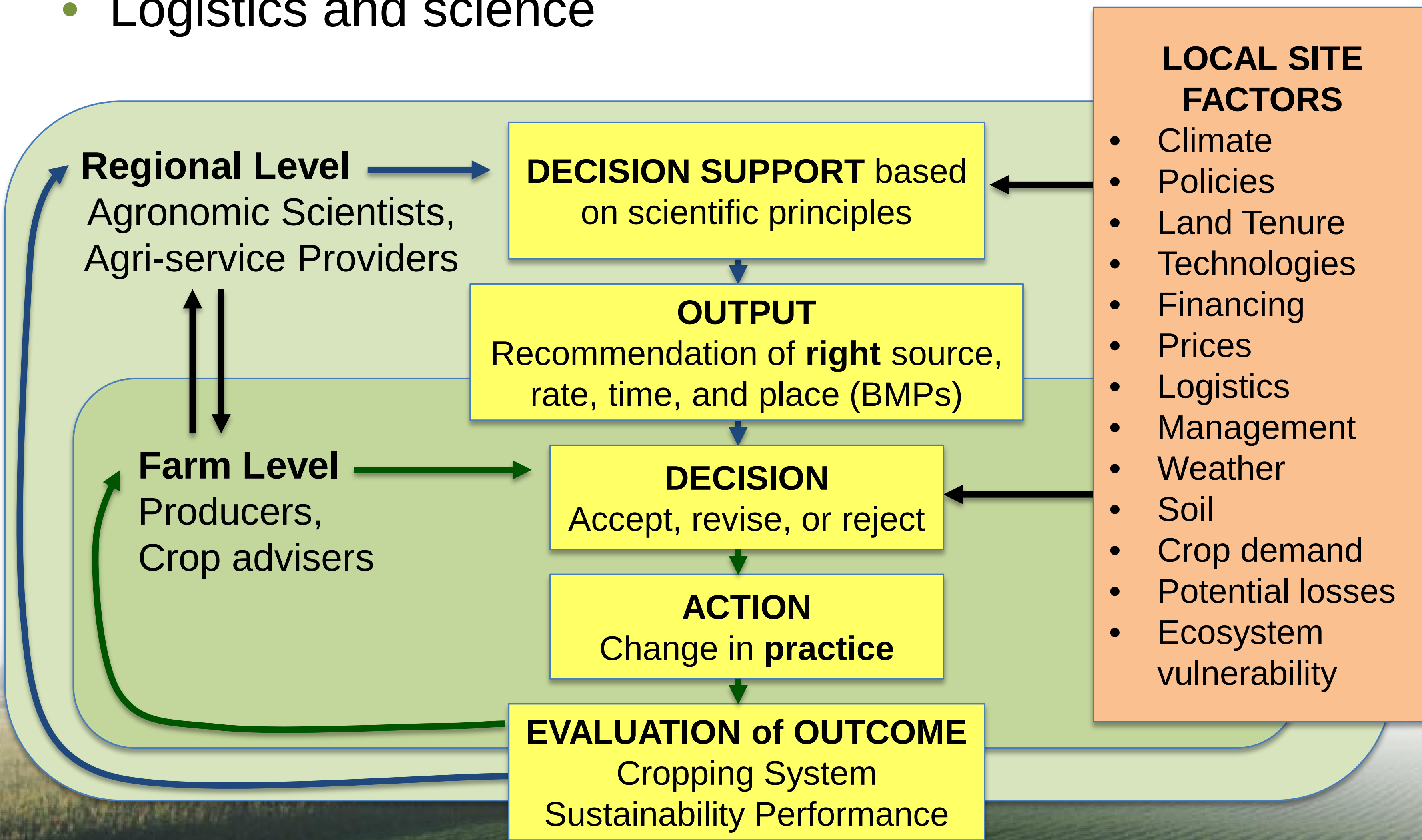
BMP adoption and evaluation – farm level

- Adaptive management



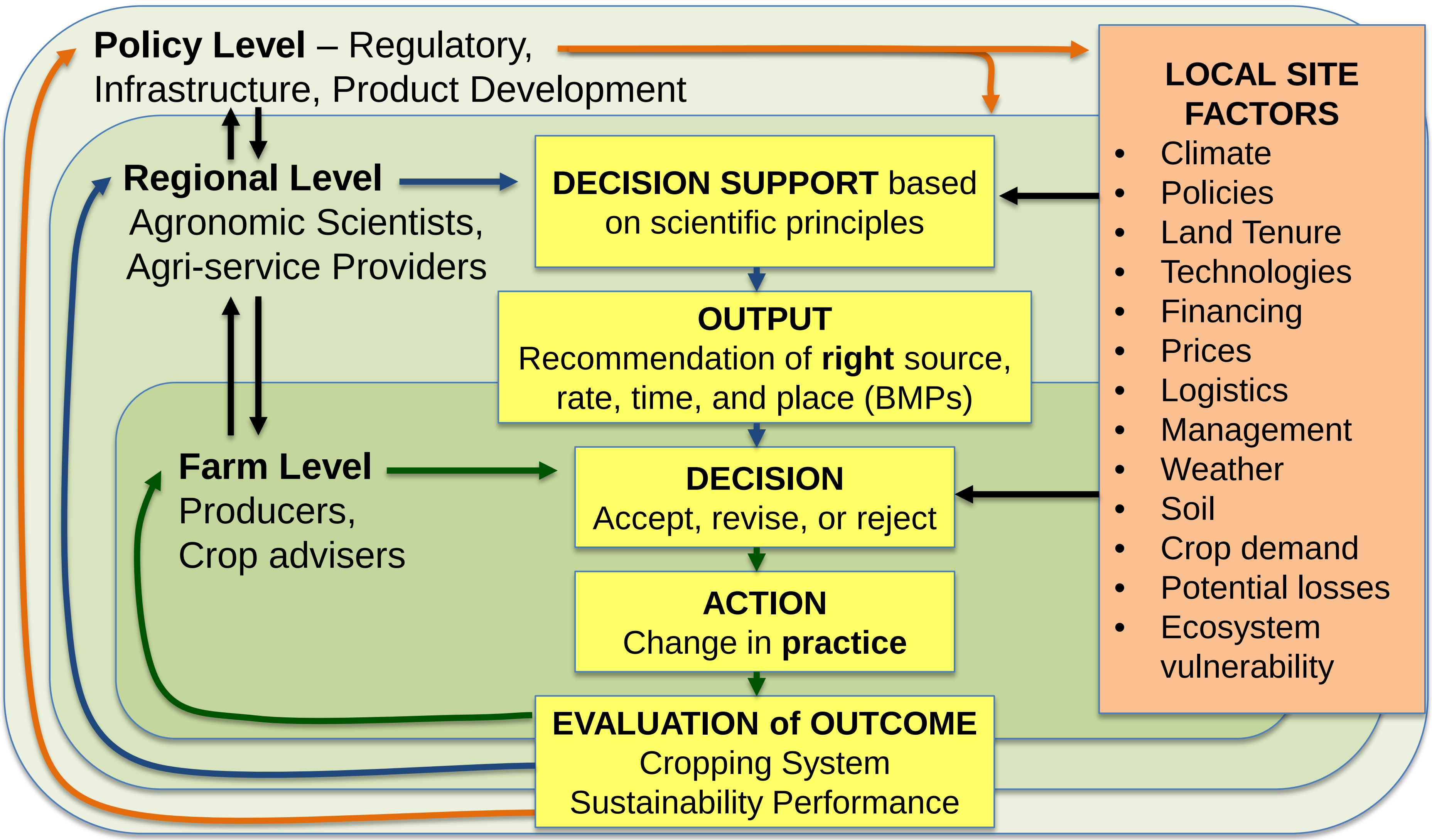
BMP adoption and evaluation – regional level

- Logistics and science



BMP adoption and evaluation – policy level

- Infrastructure and incentive



SOURCE, RATE, TIME, AND PLACE

- Every application has all 4
- Get all 4 right!
- Completely interconnected
- 4R Nutrient Stewardship emphasizes impact on outcomes
- Ensure practices are in accord with scientific principles

Examples of Key Scientific Principles

	The Four Rights (4Rs)			
	Source	Rate	Time	Place
Key Scientific Principles	• Ensure balanced supply of nutrients • Suit soil properties	• Assess nutrient supply from all sources • Assess plant demand	• Assess dynamics of crop uptake and soil supply • Determine timing of loss risk	• Recognize crop rooting patterns • Manage spatial variability

Scientific Principles for Right Rate

- Consider source, time and place
- Assess plant nutrient demand
- Assess soil nutrient supply
- Assess all available nutrient sources
- Predict fertilizer use efficiency
- Consider soil resource impacts
- Consider economics

Nutrient uptake per unit of yield: U.S.

Crop	Harvested unit	lb uptake/harvested unit		
		N	P_2O_5	K_2O
Bermudagrass	ton	46	12	50
Corn	bu	1	0.54	1.4
Rice	bu	0.71	0.38	1.1
Soybean	bu	4.9	1.1	2.3
Wheat, spring	bu	2.2	0.76	1.5
Wheat, winter	bu	1.9	0.68	2

Assessing soil nutrient supply

Right rate is a function of nutrient contribution from indigenous sources

Factor	N	P	K	S	Ca and Mg	Micros
Soil pH	x	x	x	x	x	x
Moisture	x	x	x	x	x	x
Temperature	x	x	x	x	x	x
Aeration	x	x	x	x	x	x
Soil organic matter	x	x		x	x	x
Amount of clay	x	x	x	x	x	x
Type of clay		x	x		x	x
Crop residues	x	x	x	x	x	x
Soil compaction		x	x			
Nutrient status of soil		x	x		x	
Other nutrients		x	x		x	x
Crop type	x	x		x		x
Cation exchange capacity (CEC)			x		x	x
% CEC saturaton					x	

- Availability of nutrients are governed by soil physico-chemical environment

Mechanisms influencing soil supply

- Mineralization/immobilization
- Adsorption/desorption
- Precipitation/dissolution
- Reduction/oxidation
- Root interception, mass flow, diffusion

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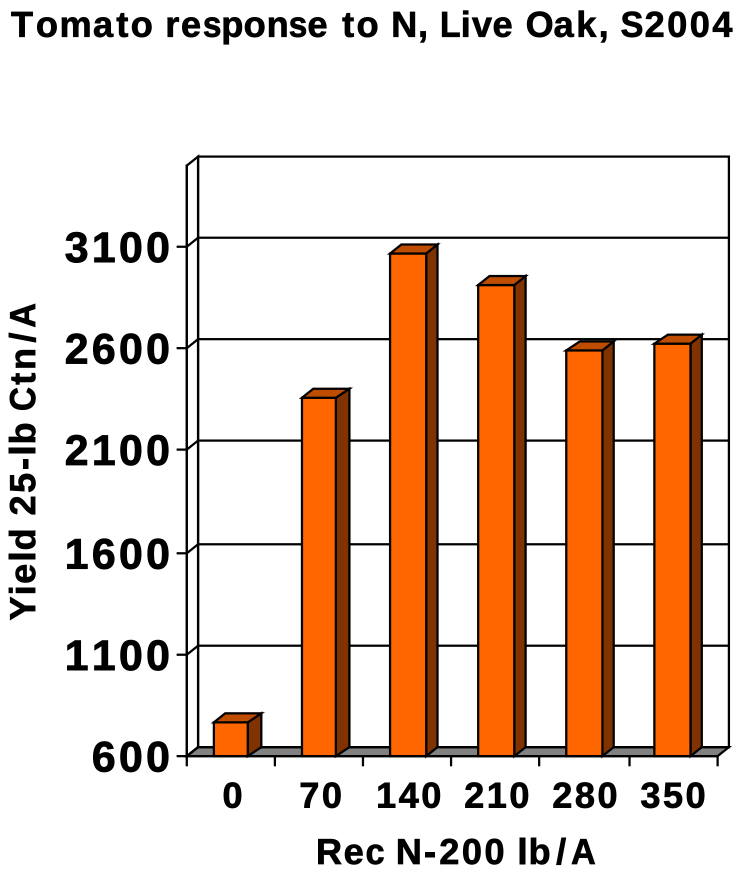
Research is important

Hochmuth, 2015

Right Rate – Drip-irrigated Tomato Yield Response to N



Hochmuth, 2015

Consider all available nutrient sources

Adjust rates of externally applied nutrients for:

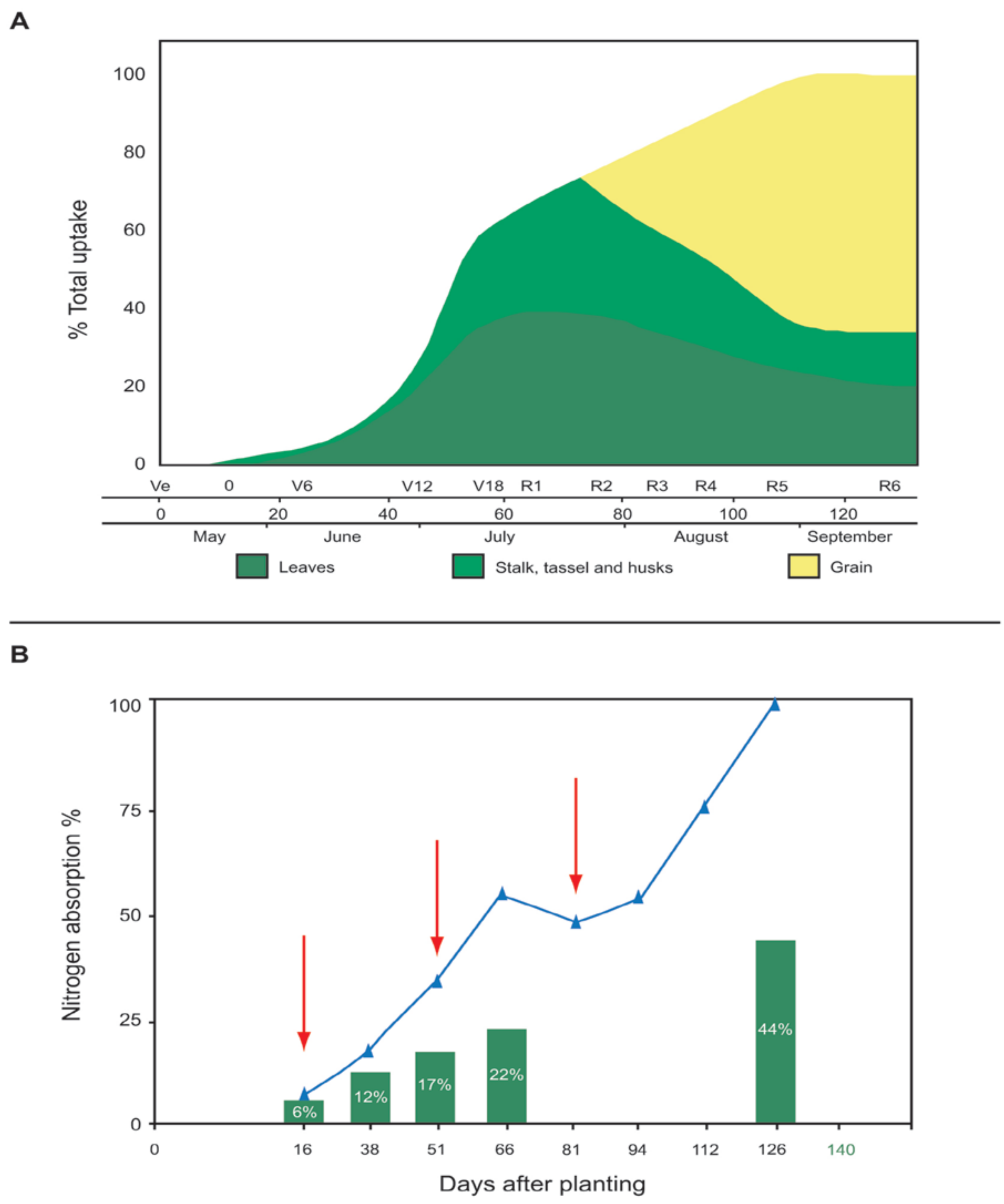
- Native soil supply
- Organic manure
- Irrigation water
- Crop residues
- Biological N fixation

Principles Supporting Right Time

- Consider source, rate, and place of application
- Assess timing of plant uptake
- Assess dynamics of soil nutrient supply
- Recognize dynamics of soil nutrient loss
- Evaluate logistics of field operations

Crop Uptake Dynamics and Fertilizer Timing

Nutrient uptake and dry matter accumulation follow S shaped or sigmoid pattern for most crops.



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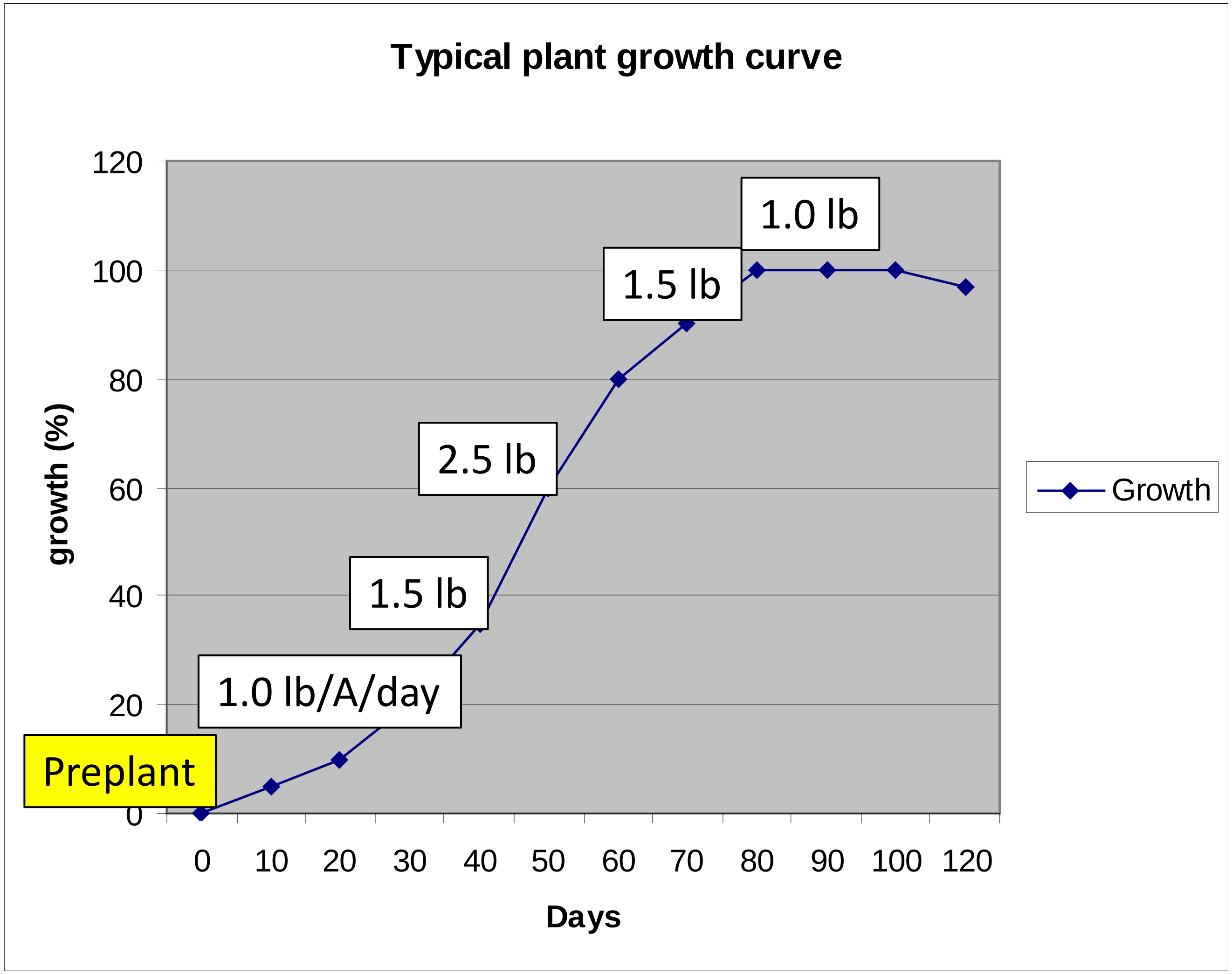


Hochmuth, 2015

Assessing Dynamics of Soil Nutrient Loss

Loss of N and P have the most potential for environmental impact

Mechanisms of loss for N and P are very different

P normally lost through runoff, making placement important in avoidance

Logistics of Field Operations Affect Timing Decisions

- Application timing decisions are governed by practicality
- As farm size has increased, logistics of planting and input timing have changed
- Fall input, where reasonable, can save valuable time in the spring
- P and K by nature lend themselves to early application, but precautions should be taken with fall N application

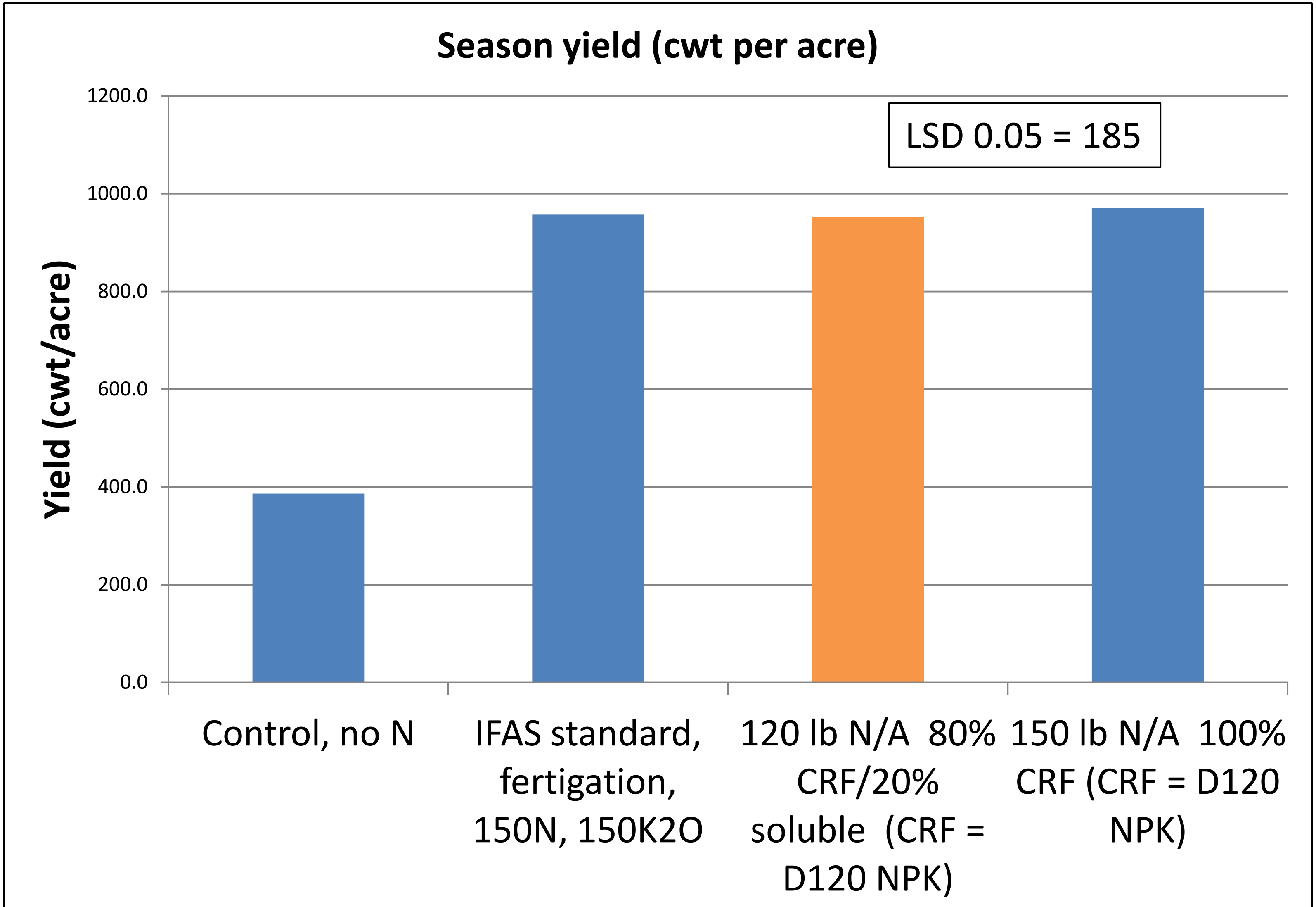
Enhanced Efficiency Fertilizer Technology May Ease Timing Pressure

- Where logistics demand a single, one-time application, EE fertilizer technologies may be useful
- These technologies include:

  Slow and controlled release fertilizer

  Nitrification and urease inhibitors

Troubadour Watermelon, polymer-coated fertilizer 2013, Citra, FL

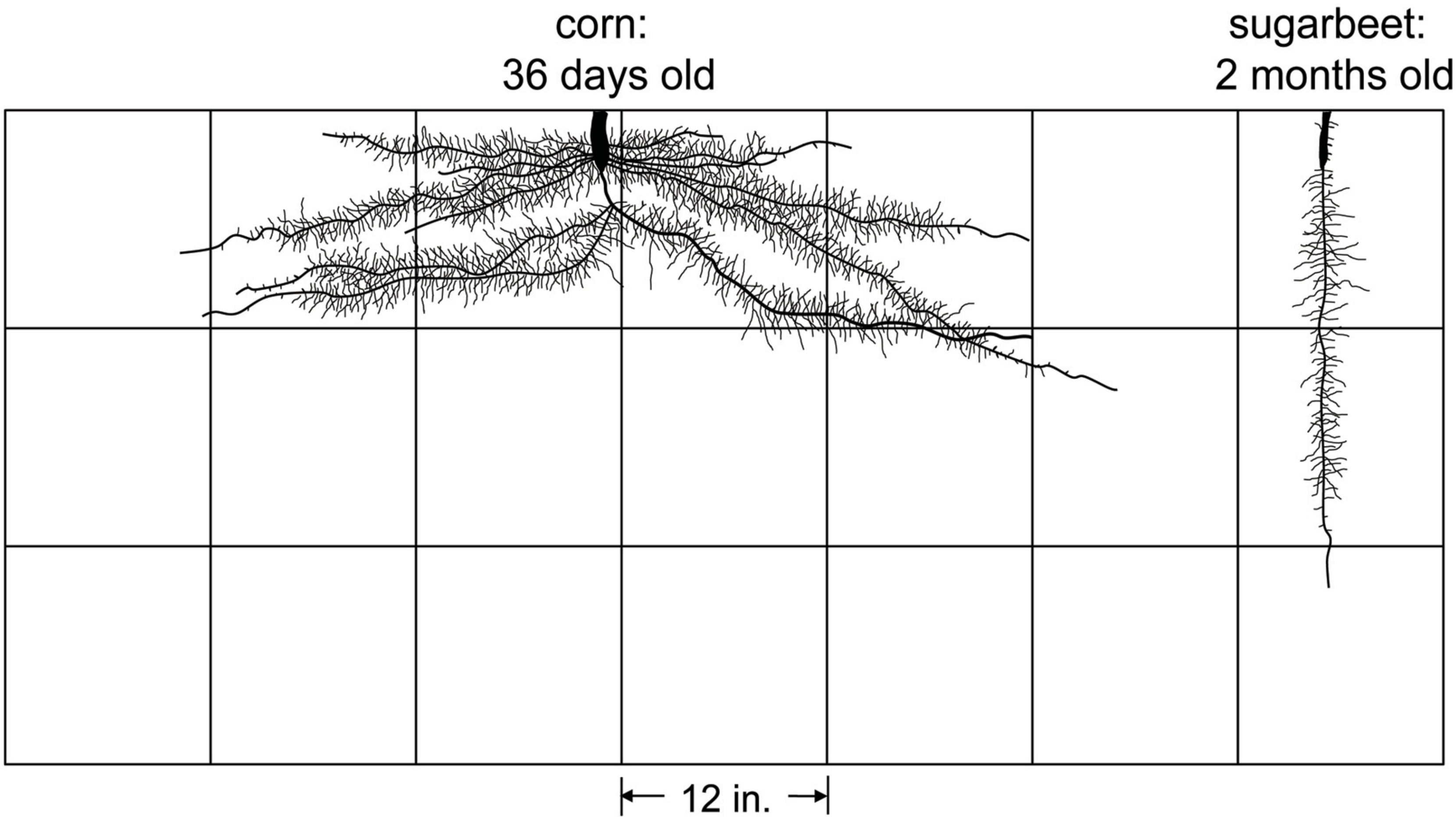


Hochmuth, 2015

Principles Supporting Right Place

- Consider source, rate, and time of application
- Consider where plant roots are growing
- Consider soil chemical reactions
- Suit the goals of the tillage system
- Manage spatial variability

Examples of Differences in Root Architecture



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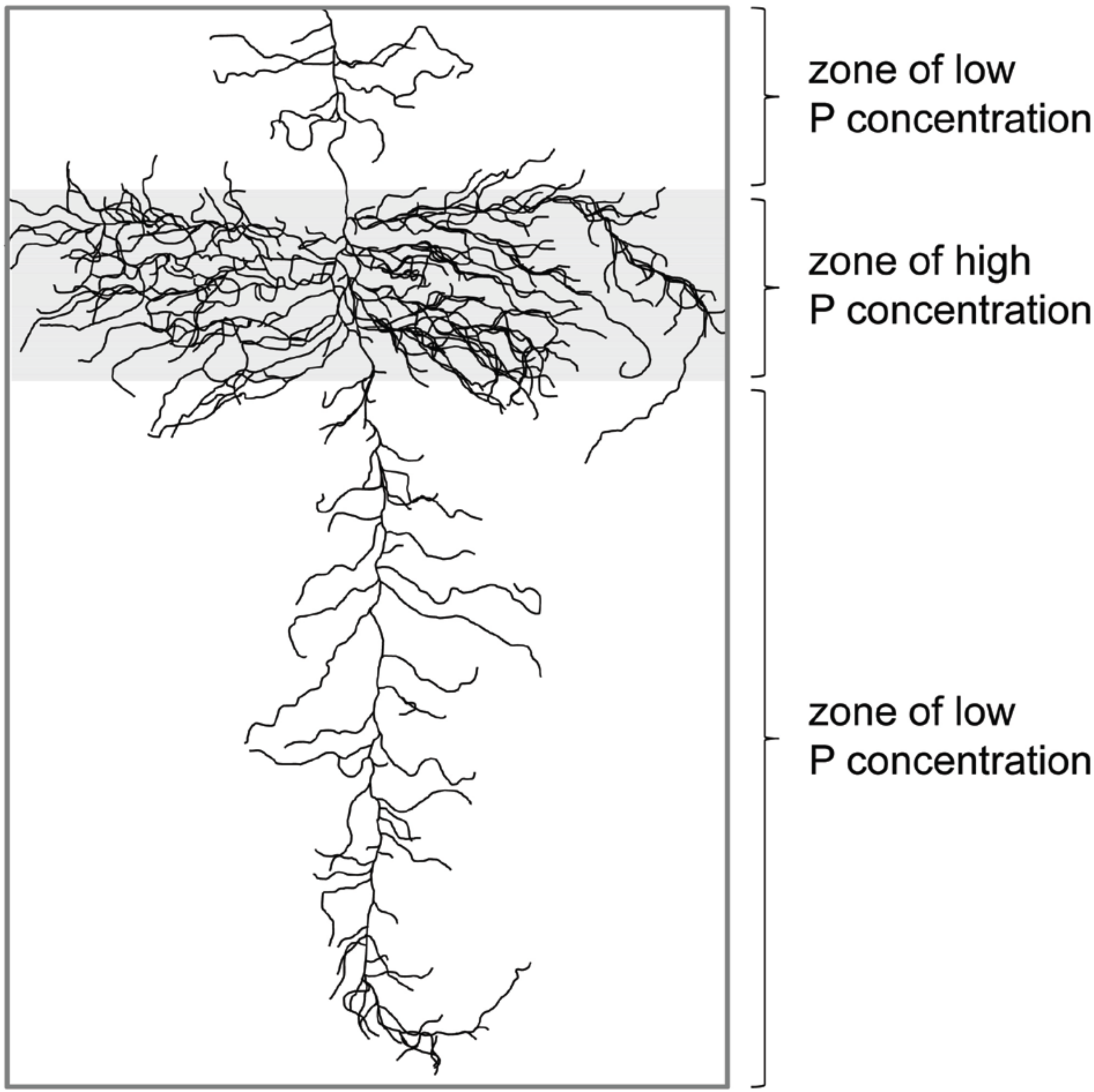
Root Plasticity



The Right Placement
Fertilizer in the root zone

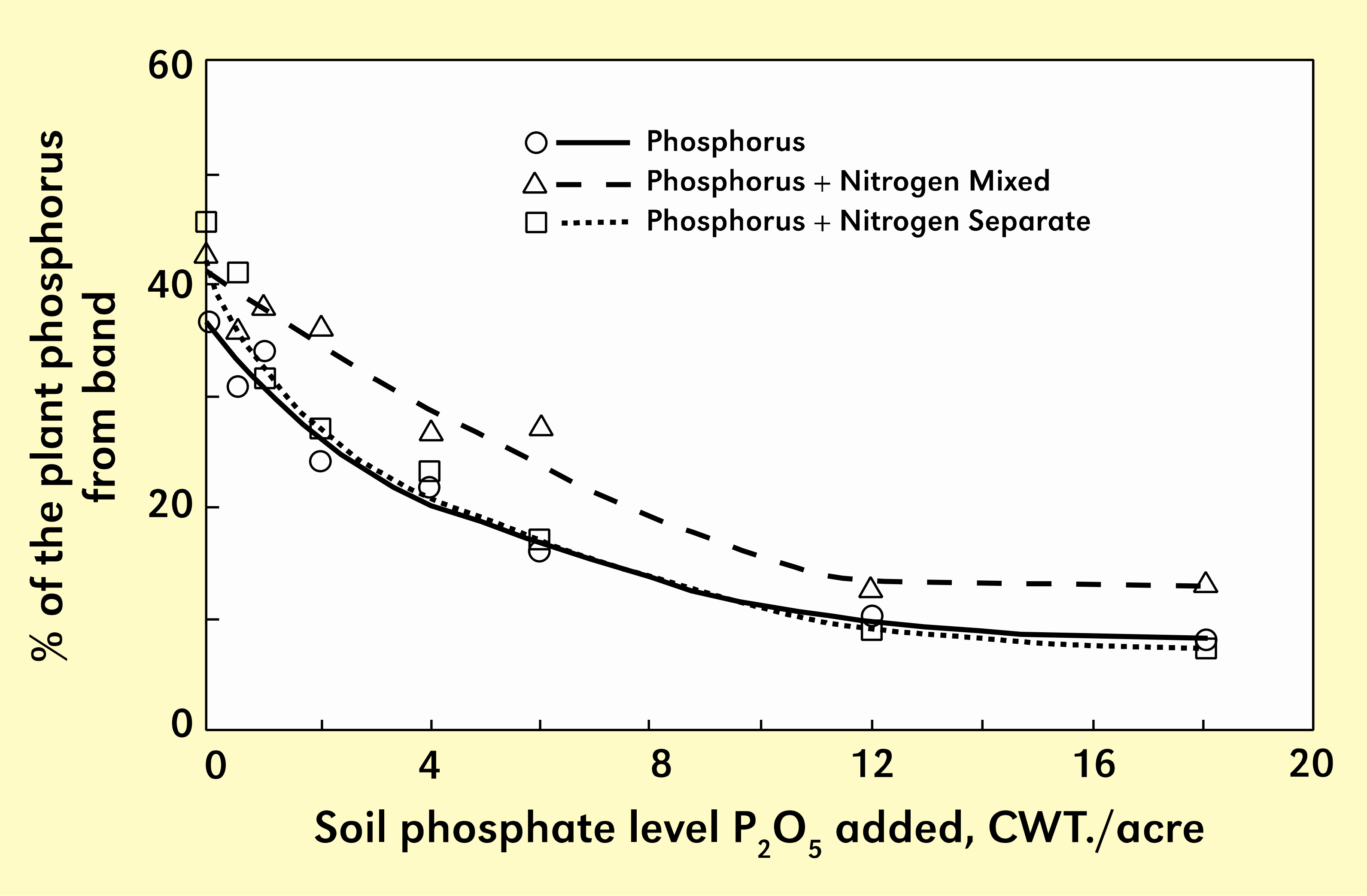
Hochmuth, 2015

Early Season Crop Needs

Banded nutrients near the seed:

- Are in close proximity to a limited root system
- Provide concentrated supplies when influx rates are highest
- Increase the rate of nutrient diffusion to roots

Nutrient Interactions within Bands



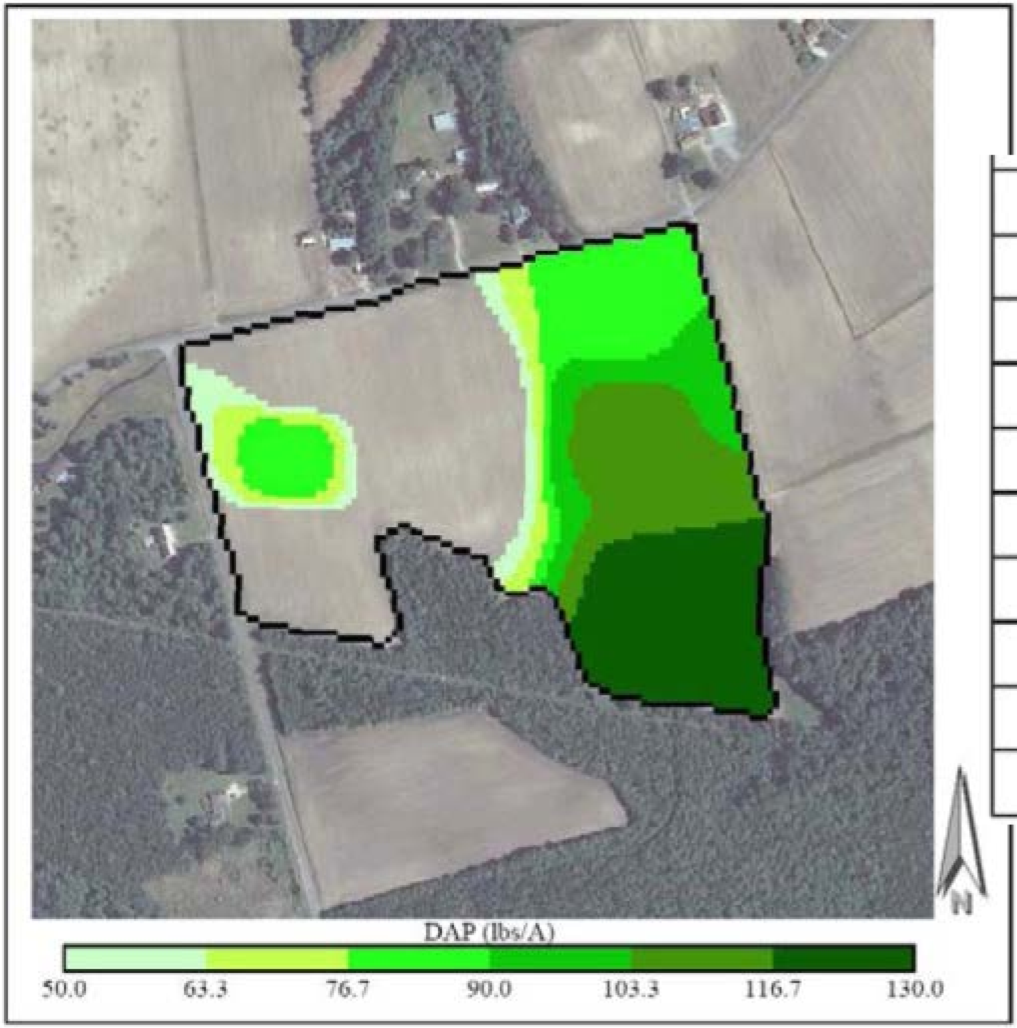
Miller and Ohlrogge,1958

Factors To Consider for Seed-Placed Fertilizer

Adjust rates of externally applied nutrients for:

- Seed sensitivity
- Fertilizer salt index
- Width of seed furrow
- Soil texture
- Soil moisture
- Amount of tolerable stand loss

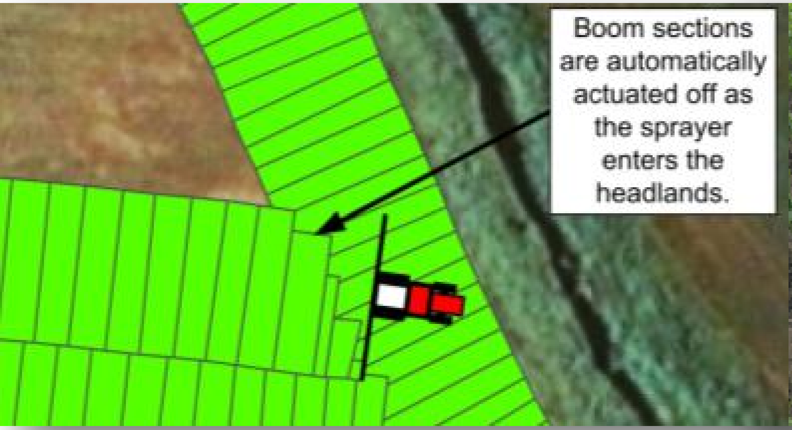
VR Phosphorus Map

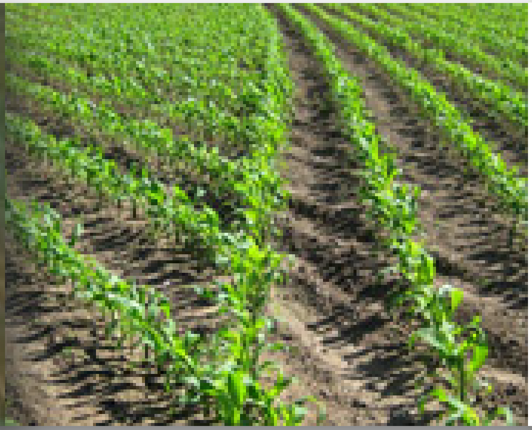


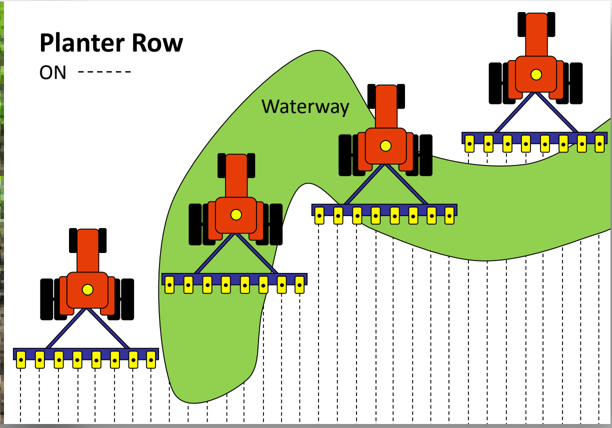
Product	
Addition/Deduction(lbs/ac):	None Entered
Percent of Original App:	100%
Minimum Application Rate:	50.0 lbs/A
Maximum Application Rate:	130.0 lbs/A
Field Average Rate:	97.64 lbs/A
Total Applied Acreage:	20.50
Total Field Acreage:	32.29
Total Field Acreage(lbs):	2001.6
Total Field Acreage(tons):	1.00

Automatic Section Control

- **Automatic ON / OFF** of sections on application equipment
  - GPS-based technology
  - Sections turn OFF: previously treated areas or unwanted areas
- **Reduces 1) overlap/skips** and **2) application in unwanted areas** (waterways, buffer strips, etc.).



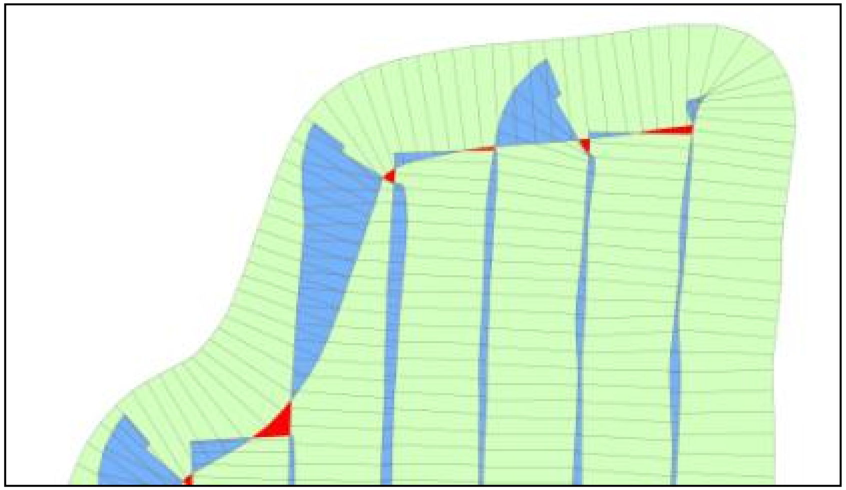




Automatic Section Control

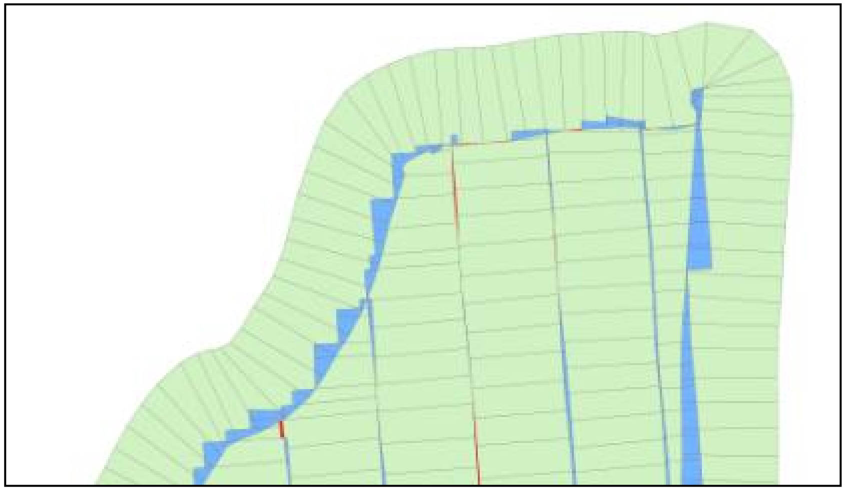
Manual Errors

- Overlaps (**blue**)
- Skips (**red**)



BSC Errors

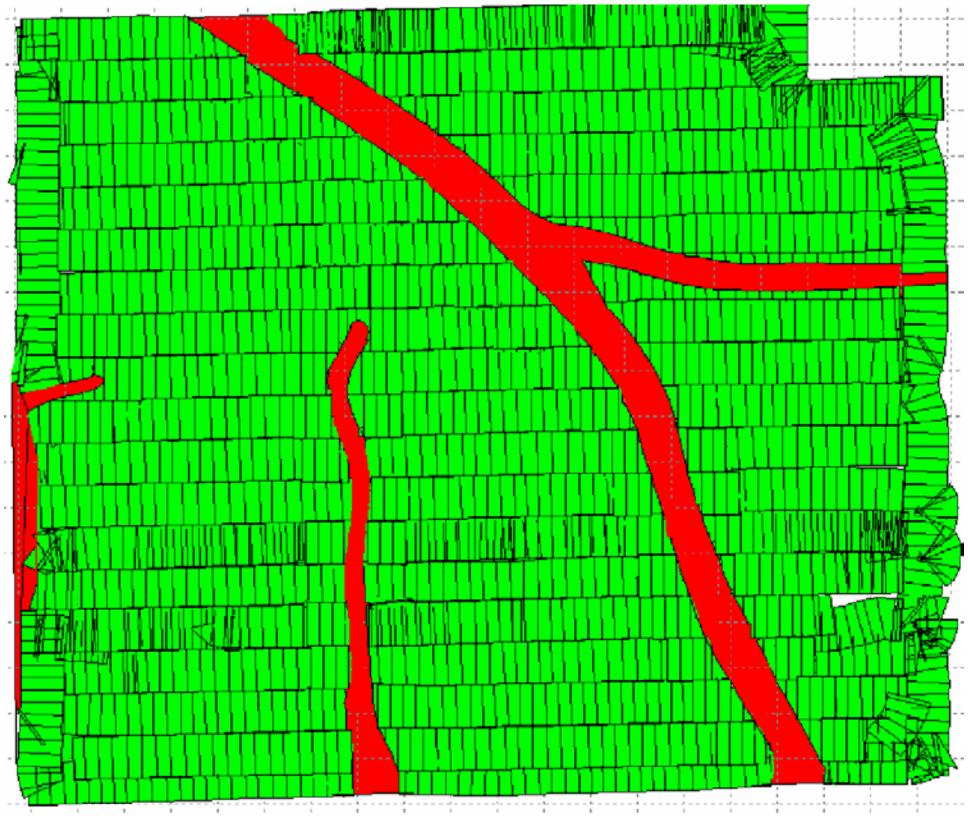
- Overlaps reduced (**blue**)
- Skips eliminated



Preservation of Conservation Features
Example during Herbicide Application

Improved Field Management

Preservation while Maintaining Production

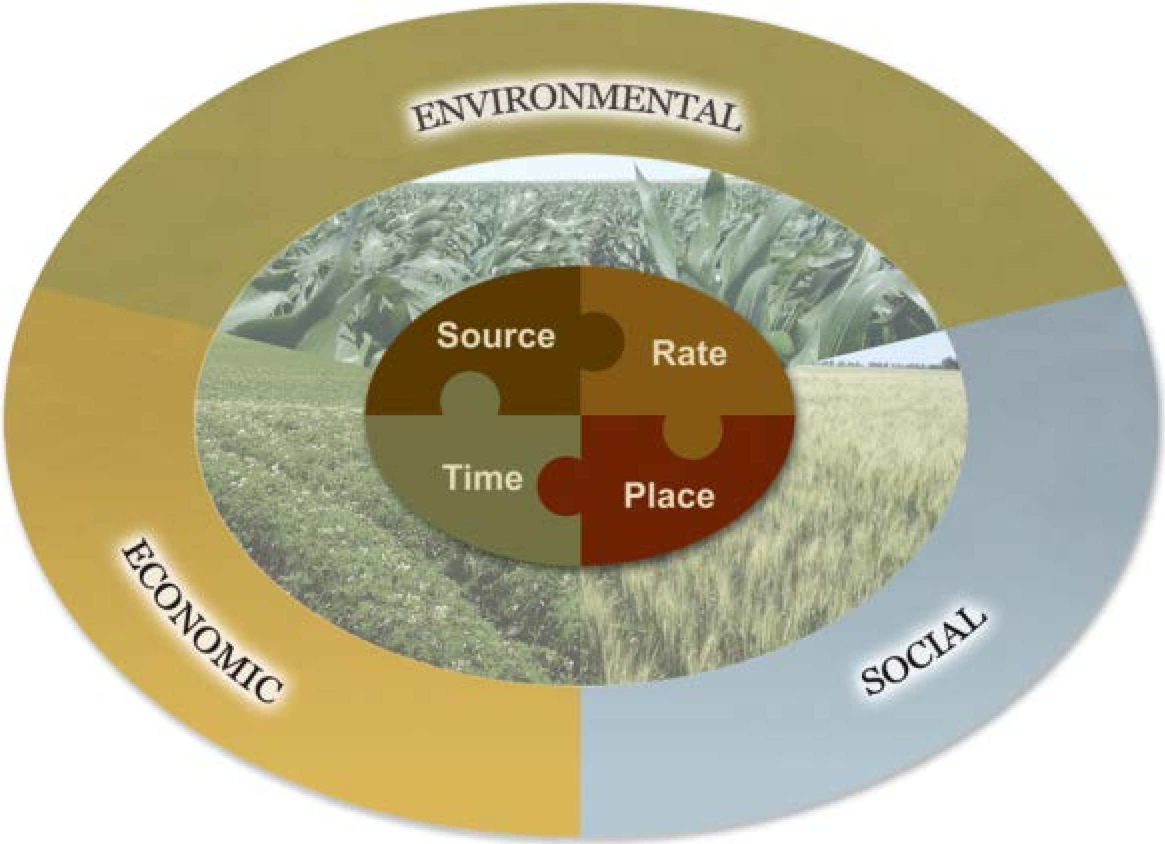


Steps to Develop a Nutrient Stewardship Plan

- Identify stakeholders
- Set sustainability goals
- Gather needed production information
- Formulate the plan
- Implement the chosen practices
- Monitor the effectiveness of the practices employed

Right means Sustainable

- **Applying the *Right Source* at the *Right Rate,* at the *Right Time,* and in the *Right Place* can help meet the environmental, economic, and social goals of sustainable agricultural systems**



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