Fertility and Nitrogen Management in Pasture Systems

MODNR-SWCP
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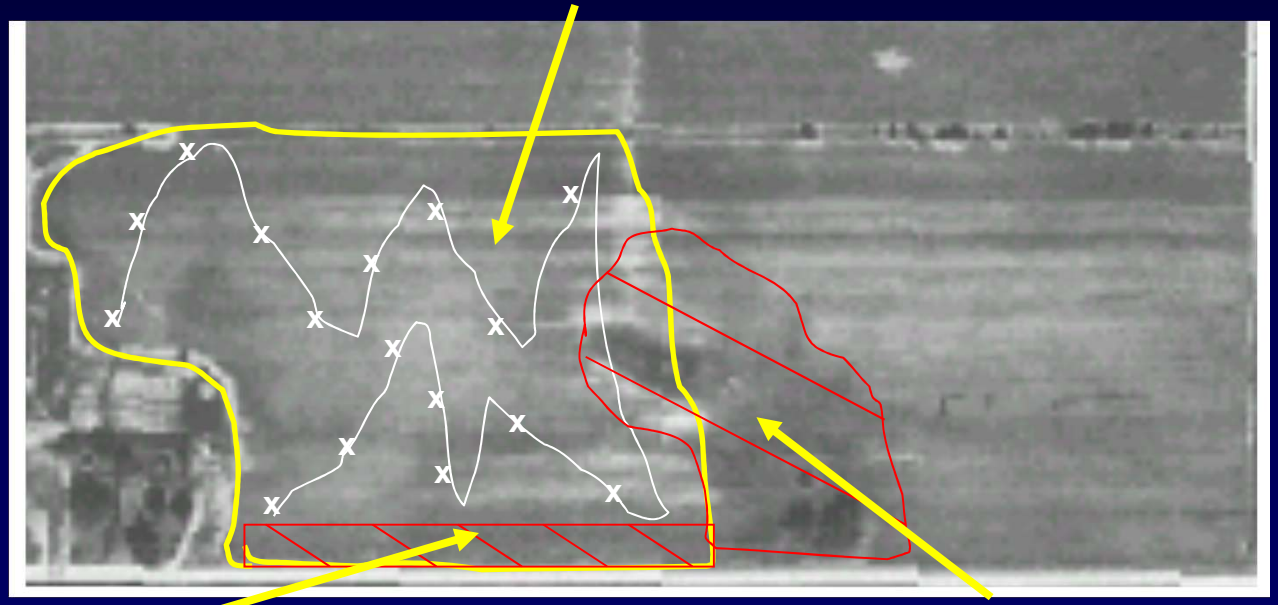
Mostly stolen from
John A. Lory, University of Missouri
and Rick Schwieter, NRCS

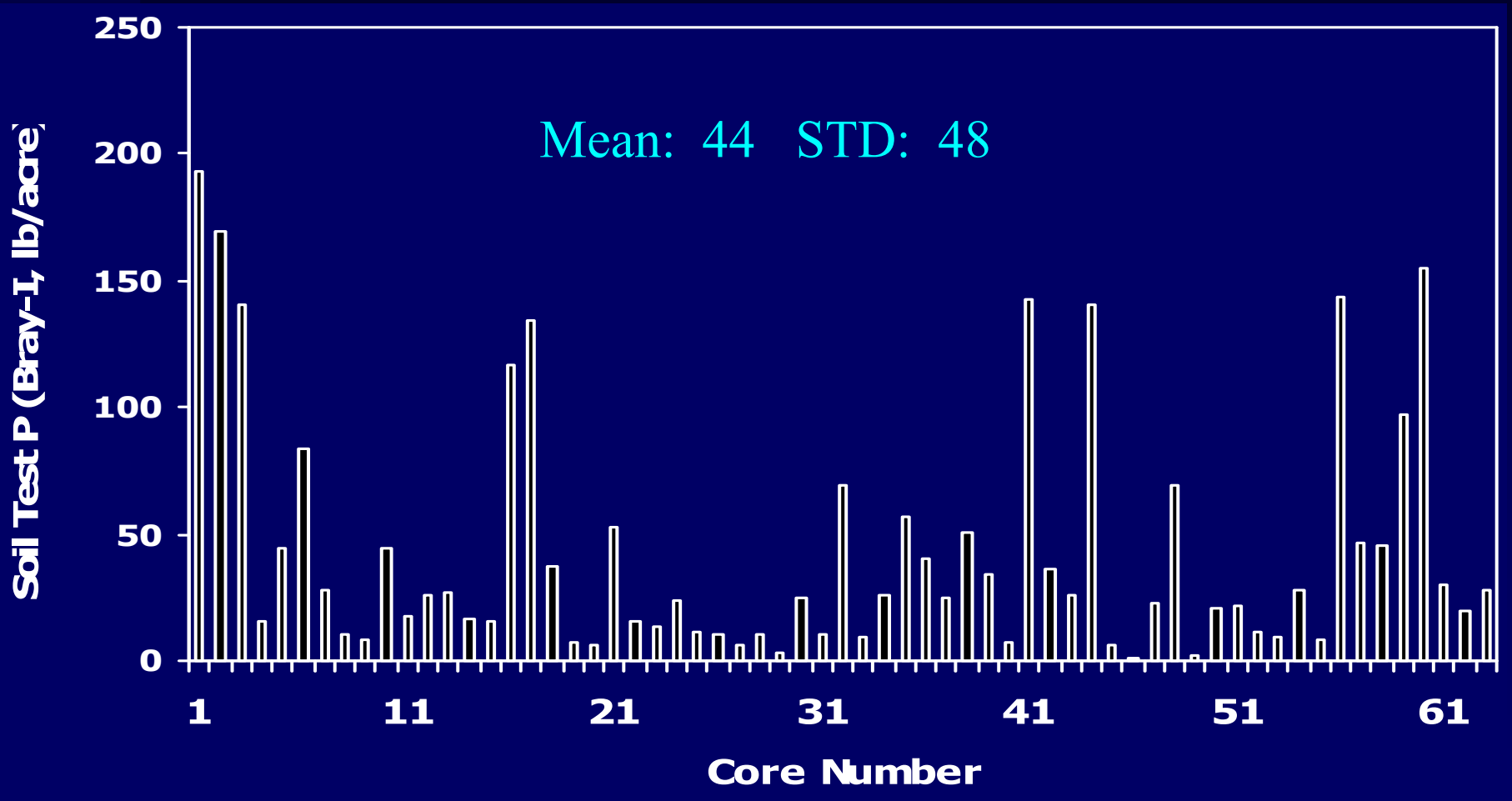
Obtaining a Quality Soil Sample

- Individual soil samples should not represent more than 20 acres.
  - 20 cores at random points along a zig-zag pattern in the field



- Avoid sampling near road
- Avoid sampling near feeding areas, water tanks, and shade trees in pasture

Soil Test Levels in the Field Are Highly Variable



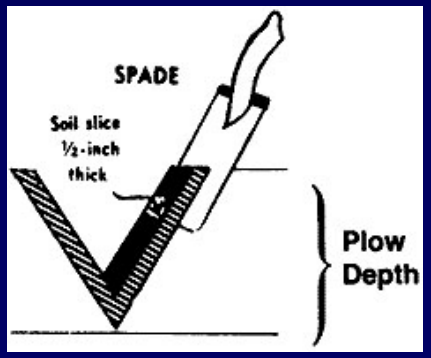
Obtaining a Quality Soil Sample (cont.)

- Sample 4 inches deep in the soil
  - Take a uniform quantity of soil from each depth
  - If using a shovel dig a hole and slice off one side
- After collecting all 15-20 cores in a bucket - crumble the soil into small pieces and mix well.
- Place about 1.5 cups in a soil sample box. Discard excess
- Label the box with the farm and field name.

Soil Sampling Devices

Probe

Screw auger (manual or cordless drill)



Tile spade

Interpreting Soil Test Results

- Low
  - Yield loss likely
  - Forage quality reduced
- Medium
  - Yield loss possible
  - Improved persistence
- High
  - Benefits from fertilization unlikely

Low pH_s (below 5)

- **Increased aluminum solubility**
  - Stunted root growth
  - Reduced nutrient uptake
- **Reduced nutrient availability**
  - Phosphorous
- **Poor legume growth**
  - Survival and activity of N fixing bacteria reduced
  - Reduced success of the symbiosis

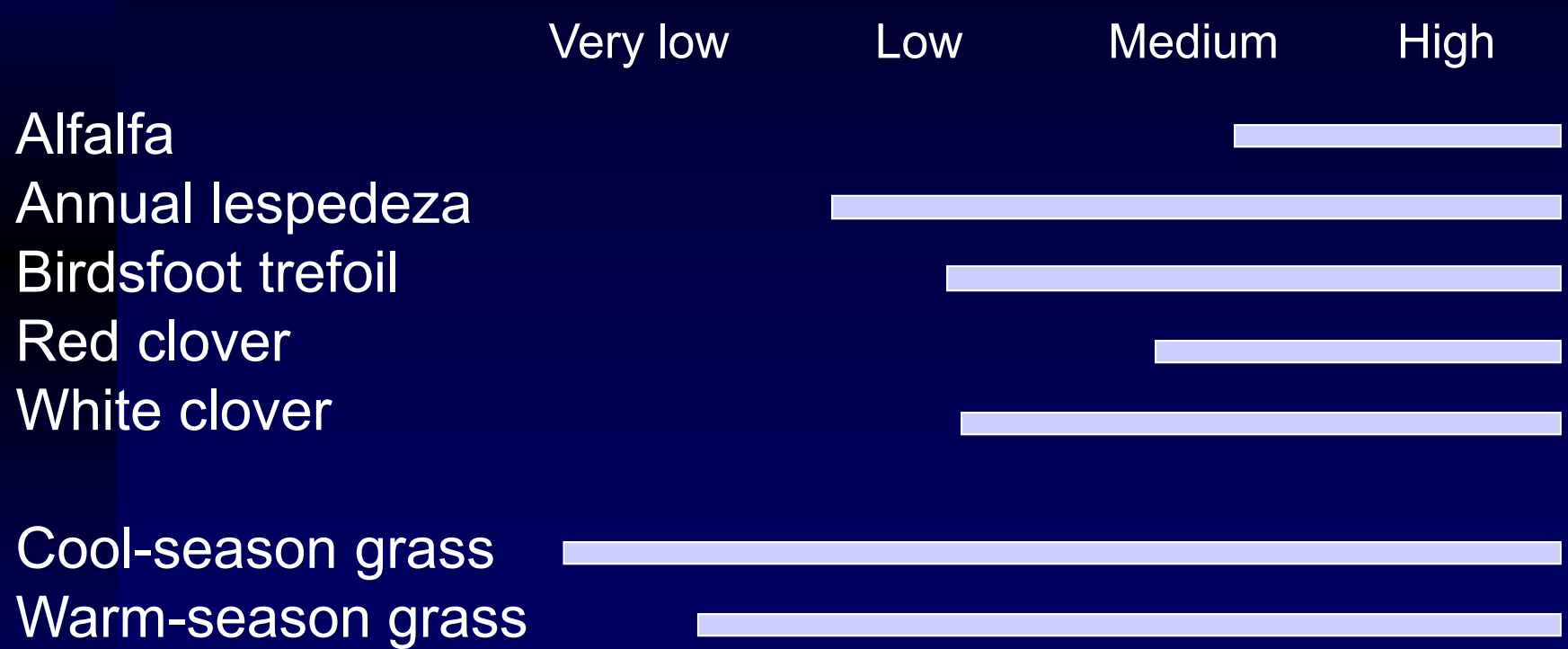
Low Phosphorus

- **Poor crop growth**
  - Critical for energy conversions in plant
  - Affects all aspects of growth
- **Poor legume growth**
  - Reduced survival and activity of N fixing bacteria

Low Potassium

- **Poor crop growth**
  - Inhibition through reduced enzyme activity
  - Impaired water uptake
- **Reduced disease resistance**
- **Reduced winter hardiness**

Soil Test Level for Persistence



Now about managing fertility:

Maintenance Applications: Hay System

Inputs

- Fertilizer
- Manure
- Legumes (N)

Nutrient Cycle

Exports

- Remove 80% of nutrients in hay

Tons of Hay Removes:

- 150 lb. Nitrogen
- 18 lb. P (40 lb. P_2O_5)
- 120 lb. K (145 lb. K_2O)

Maintenance Applications: Pasture System

Inputs

- Fertilizer
- Manure
- Legumes (N)
- Feed

Nutrient Cycle

Exports

- Calves
- Beef

Cow/calf pair, stocker removal rates

- 10 lb. Nitrogen
- 3 lb. P (7 lb. P_2O_5)
- 0.7 lb. K (1 lb. K_2O)

Phosphorus Cycle: Pasture System

Efficiency: 90 % returned

Forage	29 lb P
- Retained-animal	-3
Excreted	26 lb P

Nitrogen Cycle: Pasture System

Efficiency: Only an average of 25% of N excreted survives volatilization, solution, and other losses to be available to plants

Forage	280 lb N
- Retained	-10
Excreted	270
- Volatilization & other	-202
Returned for plants	68 lb N

Nitrogen Cycle: Pasture System (cont.)

- Recovery of excreted nitrogen by pasture plants is generally low:
  - 30% from urine
  - 10% from dung

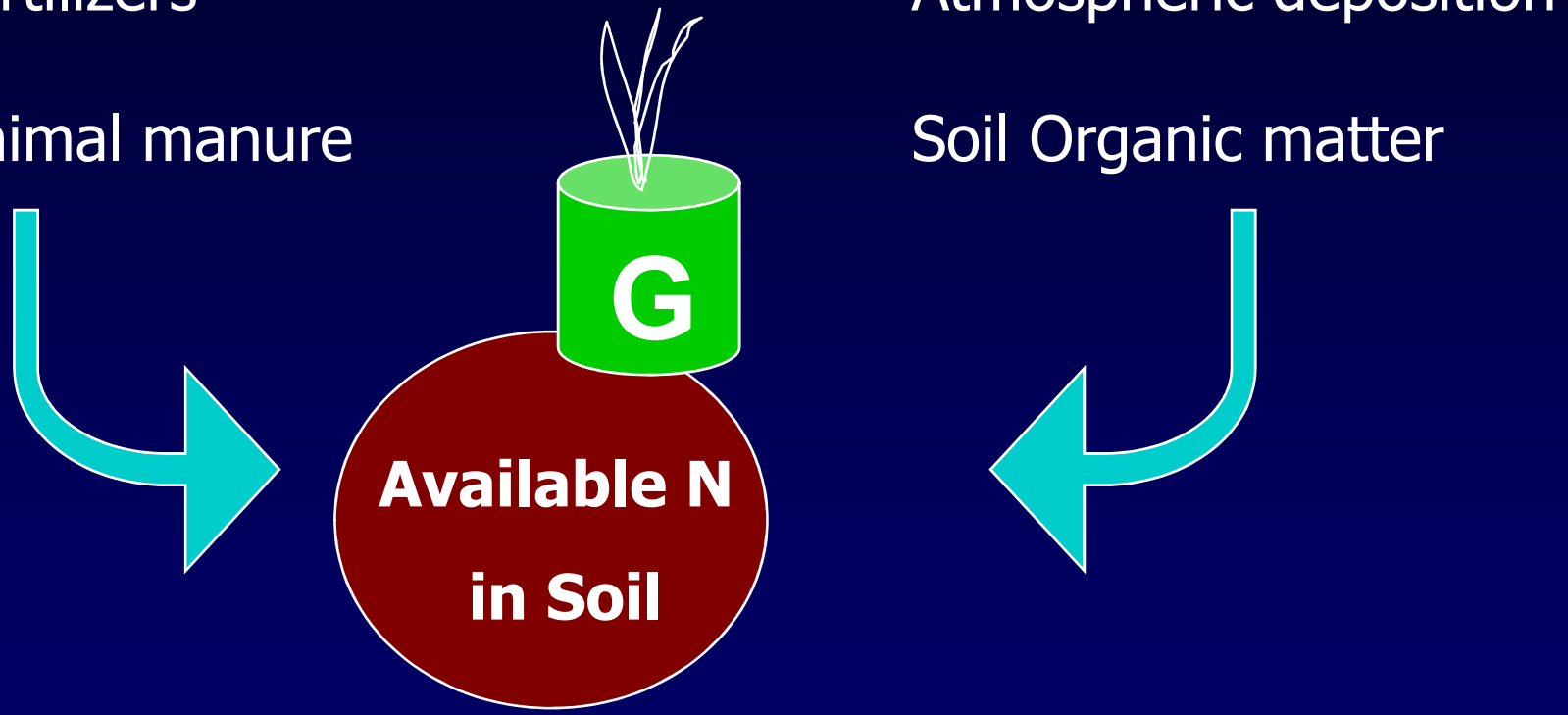
Nitrogen Cycle: Grasses

Fertilizers

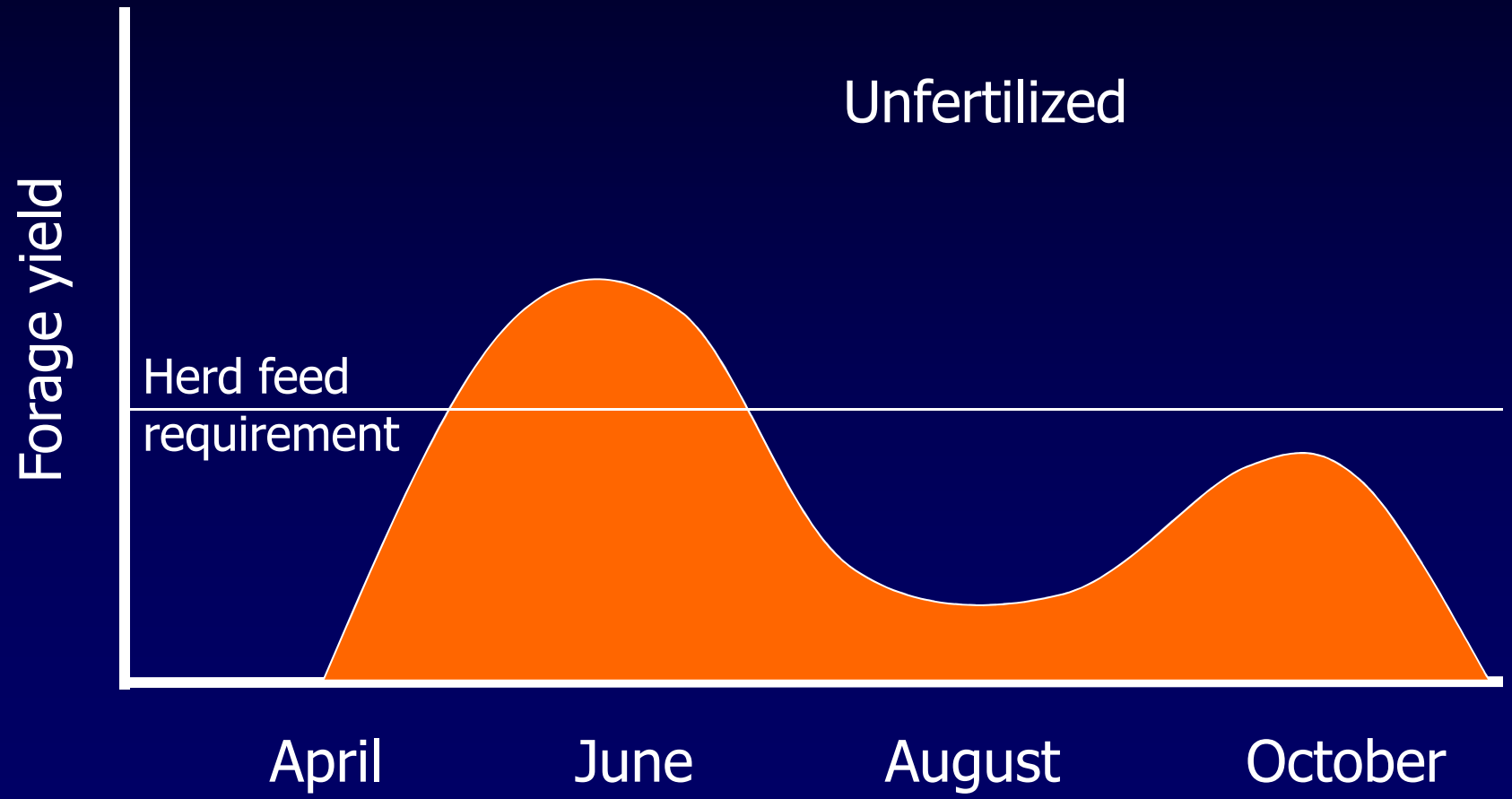
Animal manure

Atmospheric deposition

Soil Organic matter



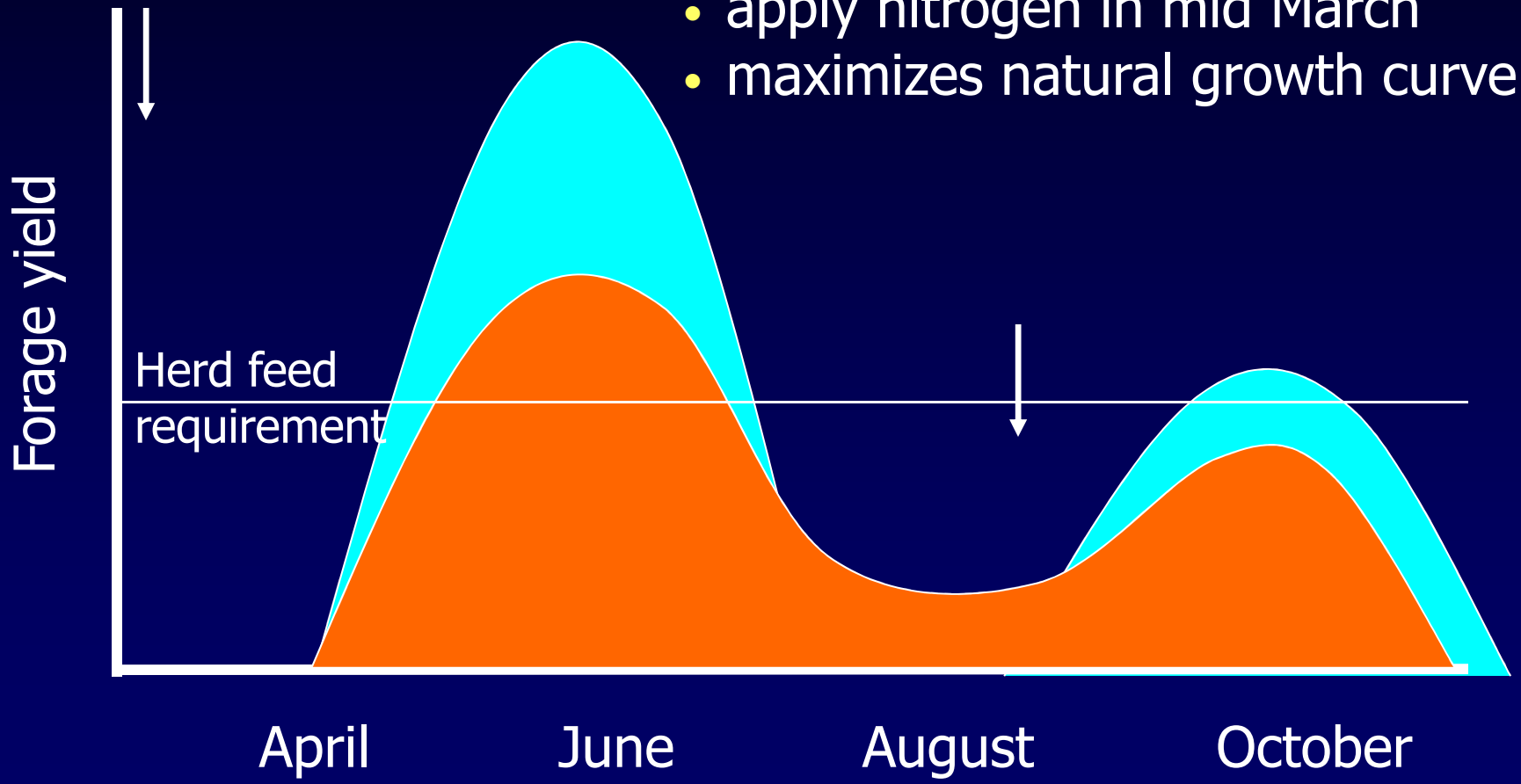
Nitrogen for Tall Fescue



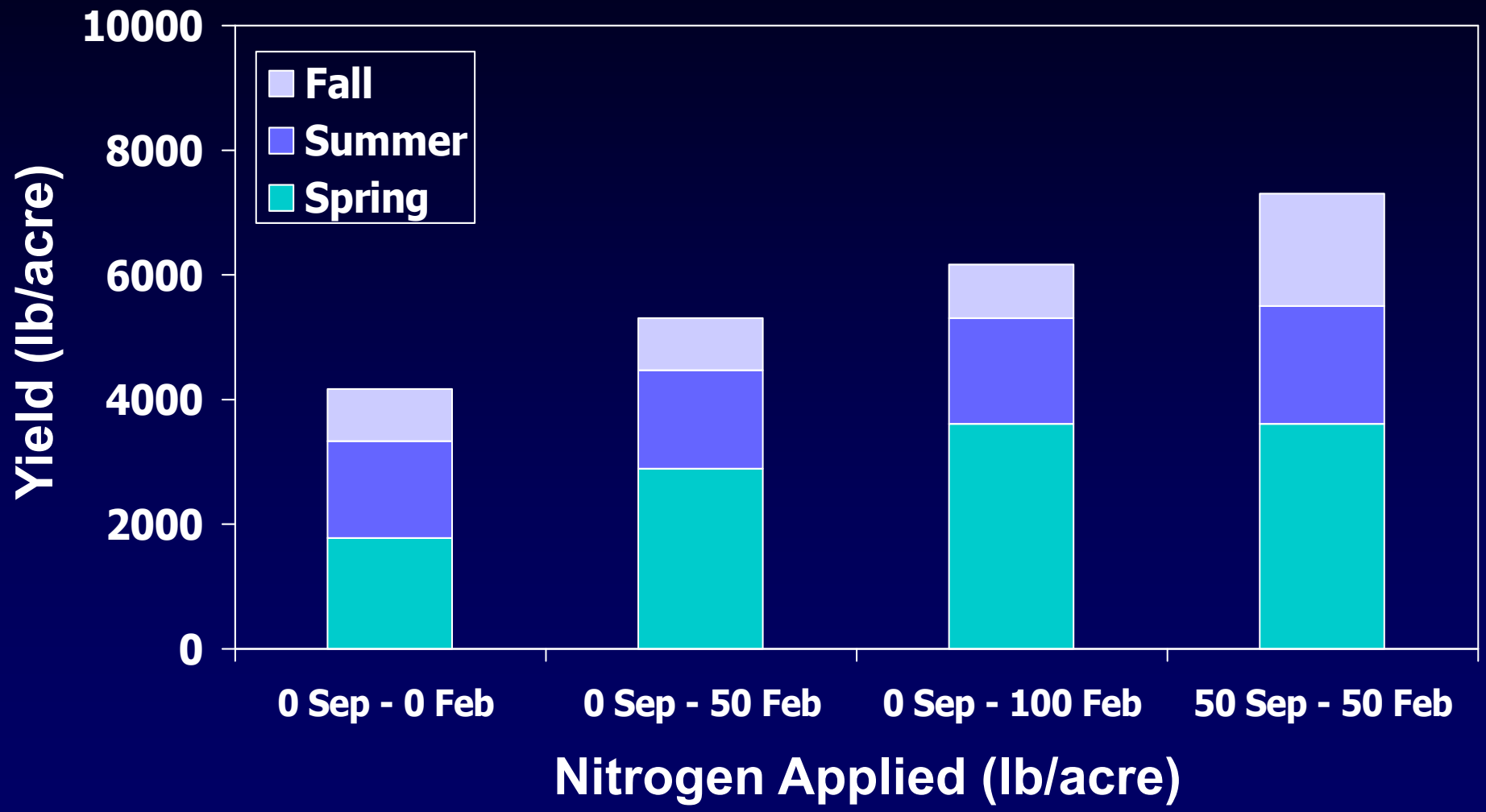
Nitrogen for Tall Fescue Hay

Traditional spring fertilization for Hay:

- apply nitrogen in mid March
- maximizes natural growth curve



Fertilization of Tall Fescue



Georgia

Hoveland and Richardson, 1992

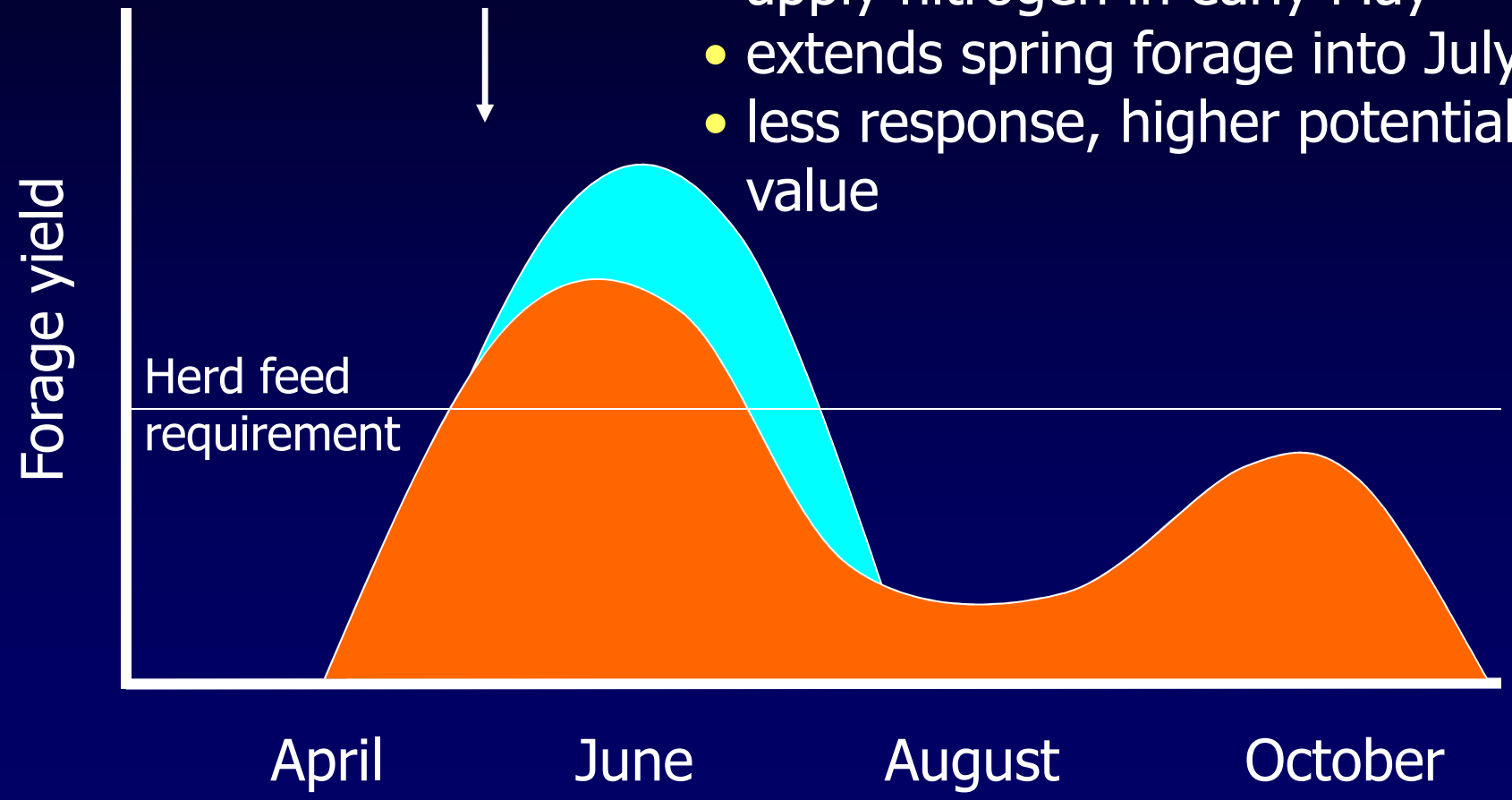
N Fertilizer for Tall Fescue Hay

- Spring application early near time plant starts growing.
  - High probability of response.
  - Harvest quality hay to make fertilizer pay.
- Fall application in mid August to promote fall growth.
  - Response depends on sufficient fall moisture
- Typical split: 60% – 40% with highest rate in the season that you most likely to utilize the forage.

Nitrogen for Tall Fescue Pasture

Spring fertilization for Pasture:

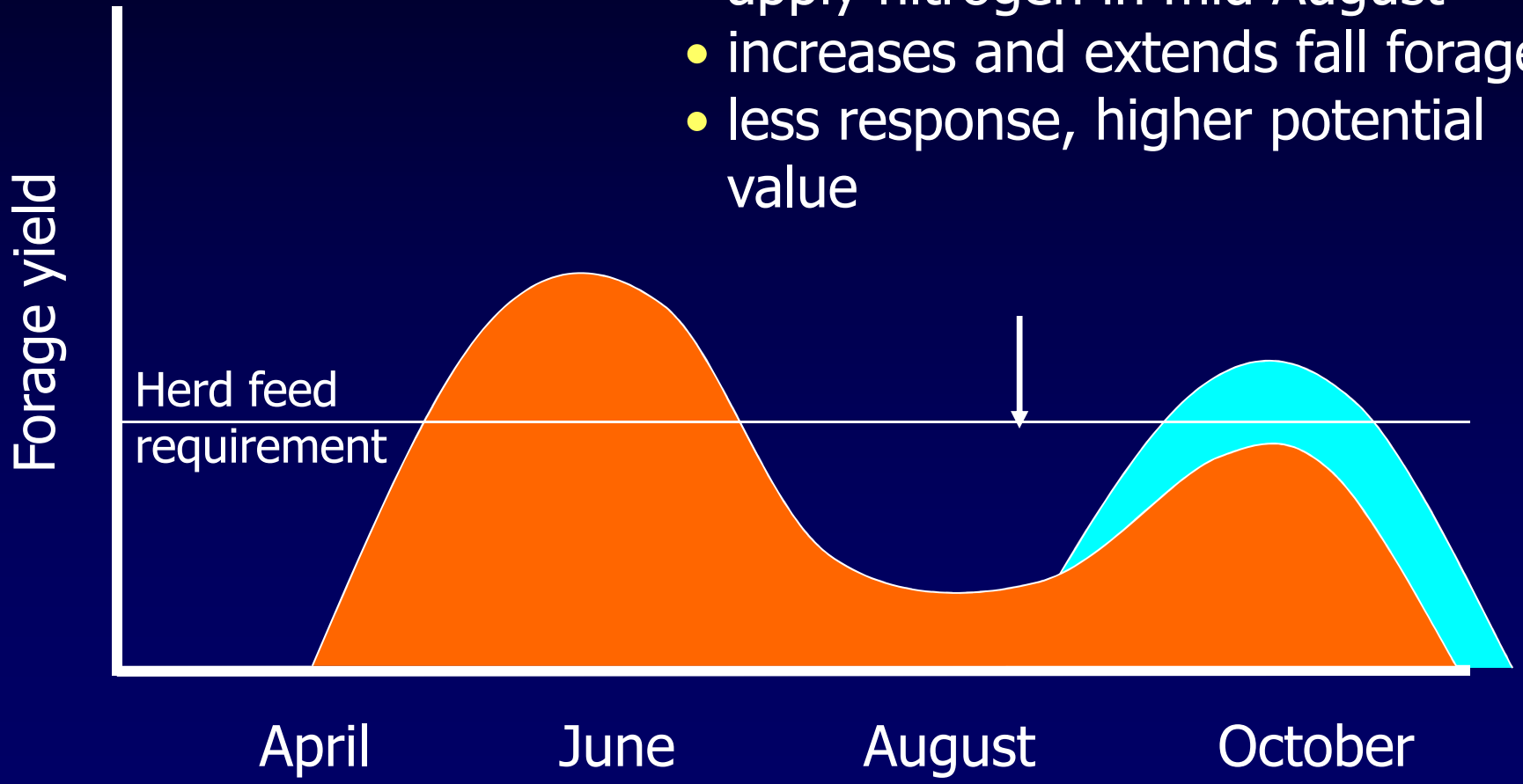
- apply nitrogen in early May
- extends spring forage into July
- less response, higher potential value



Nitrogen for Tall Fescue Pasture

Fall fertilization for Pasture:

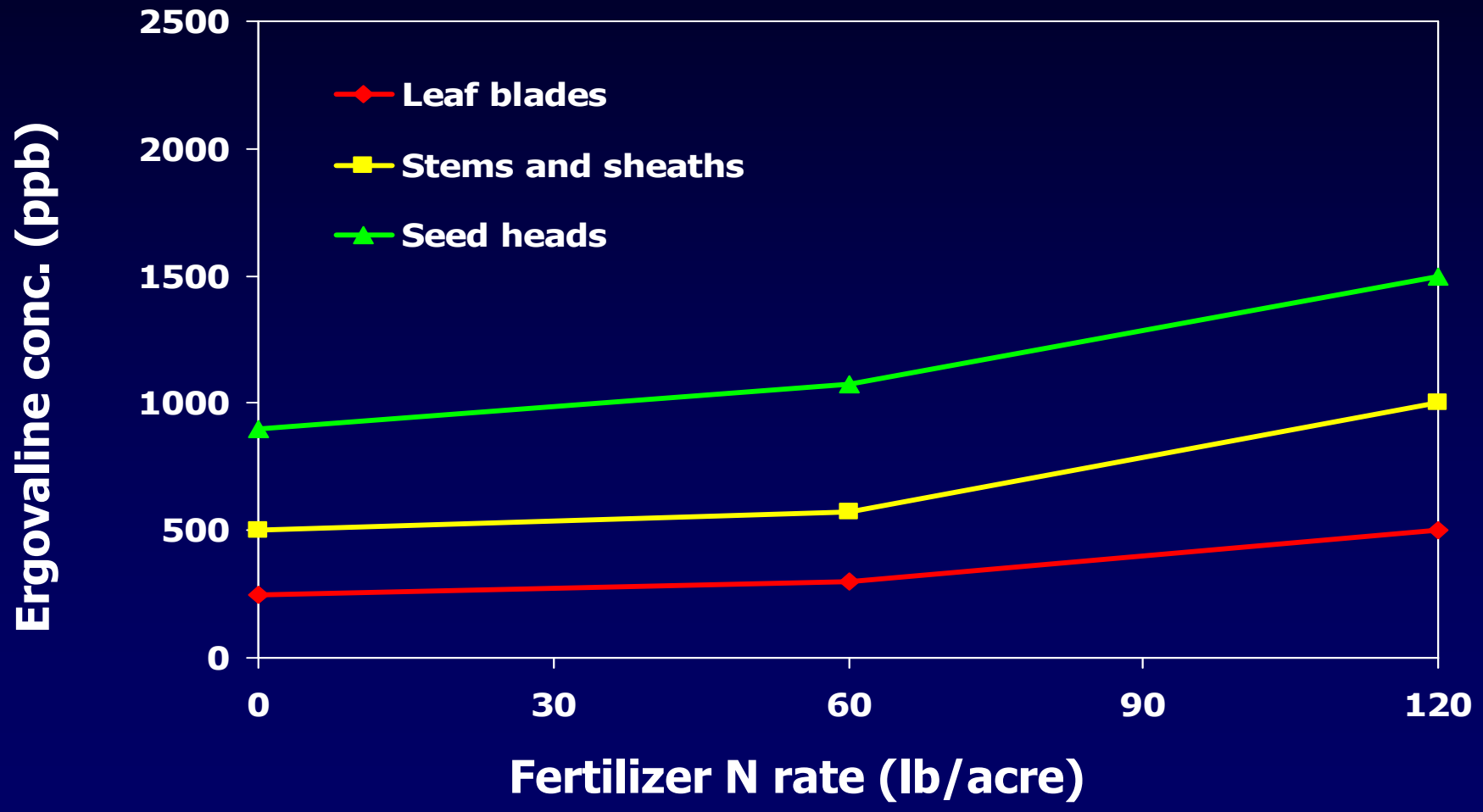
- apply nitrogen in mid August
- increases and extends fall forage
- less response, higher potential value



N Fertilizer for Tall Fescue Pasture

- Spring application after early grazing (late April to early May) *if forage is needed*.
  - High probability of response.
  - Fertilization later than hay promotes more late spring growth
- Fall application in mid August to promote fall growth.
  - Response depends on sufficient fall moisture
  - Fall forage valuable in pasture systems

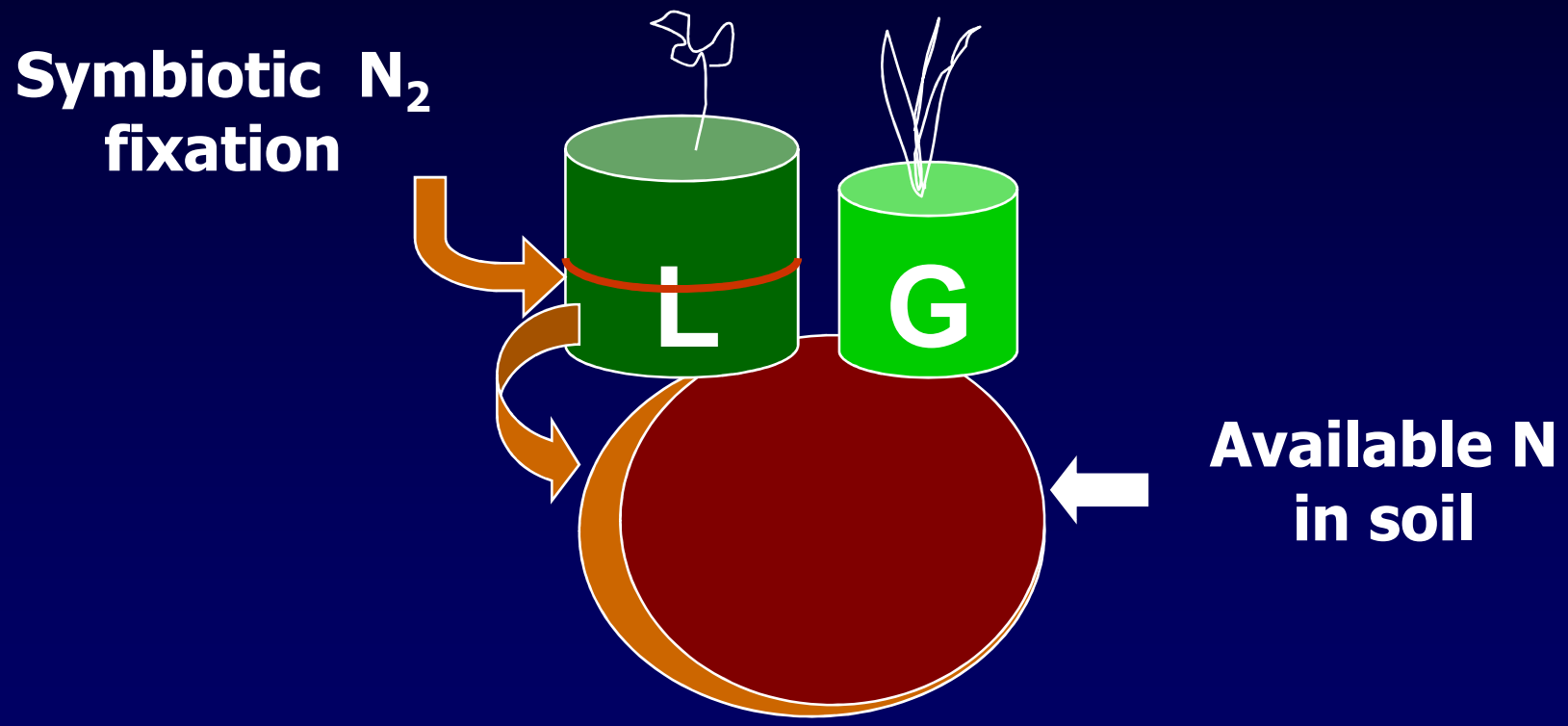
Ergovaline Concentration: Tall Fescue

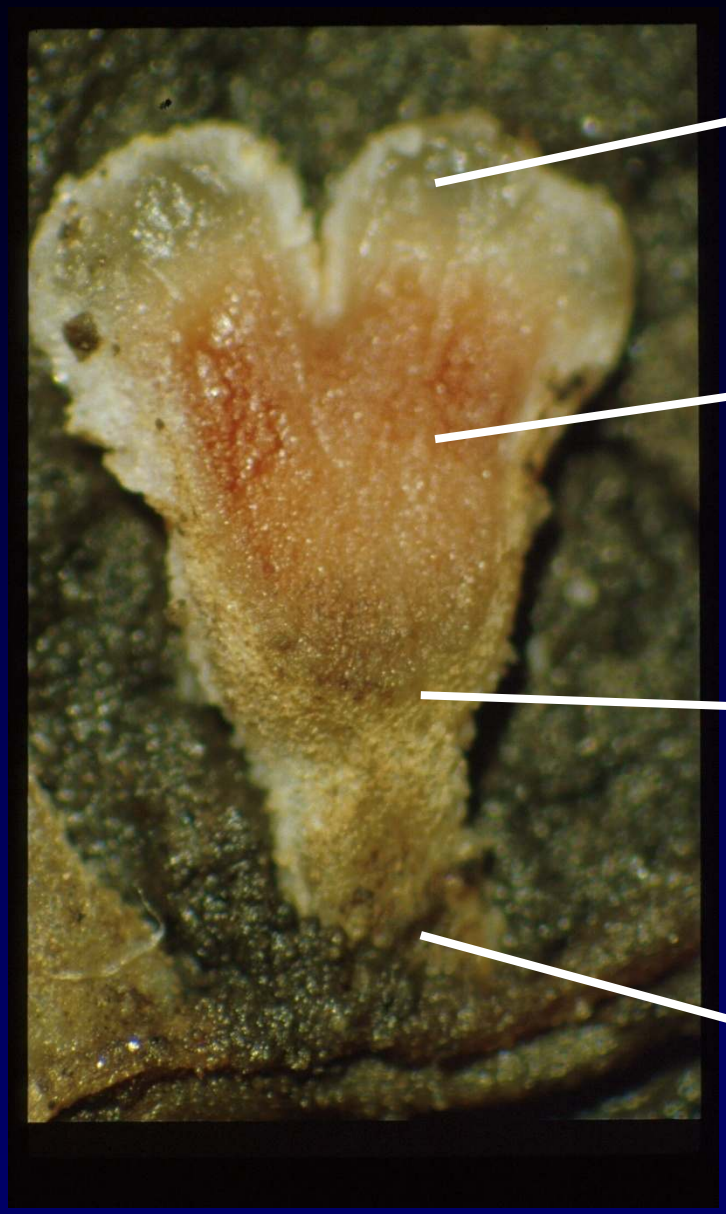


Columbia, MO

Rottinghaus et al., 1991

Nitrogen Cycle: Grasses and Legumes





Growing zones

Leghemoglobin (N_2 fixing zone)

Inactive zone

Attachment point
Alfalfa root

Picture from Michael Russelle, USDA-ARS

Host-bacteria Specificity

Host	Rhizobia
Soybean	*Bradyrhizobium japonicum*
Alfalfa	*Sinorhizobium meliloti*
Trefoil	*Mesorhizobium loti*
Vetch	*Rhizobium leguminosarum* bv *viciae*
Clovers	bv *trifolii*

BUT Kura clover more picky than others

N_2 Fixation in Mixed Stands

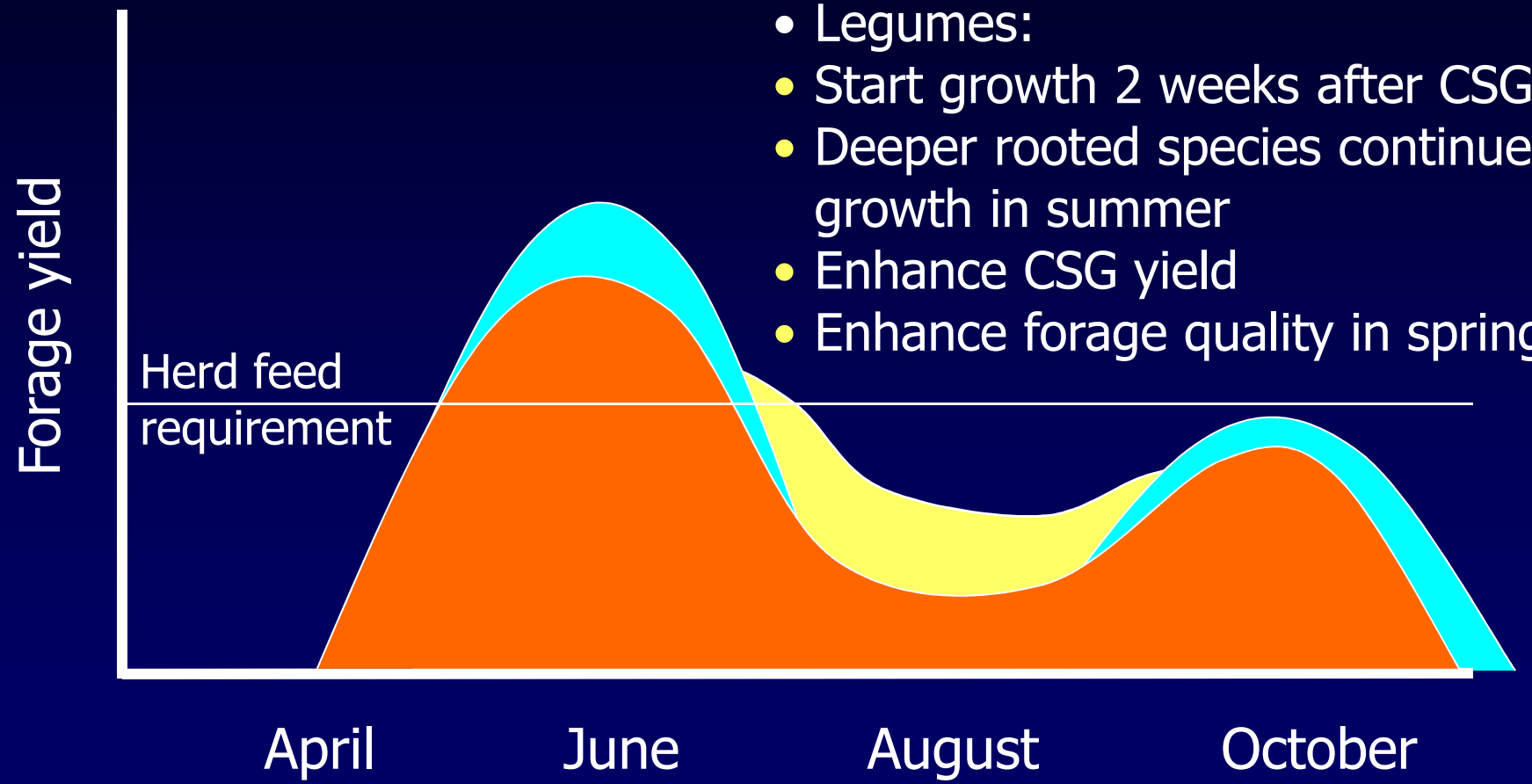
Species	N_2 Fixed (lb./a)		Ndff
	Year 1	Older	(%)
Alfalfa	70 – 80	120 – 180	60 – 94
Birdsfoot trefoil	30 – 60	80 – 150	40 – 94
Red clover	10 – 90	40 – 330	40 – 96
White clover	1 - 100	20 – 300	37 – 100

(Ledgard and Steele, 1992; West and Mallarino, 1996)

Benefits of Legumes

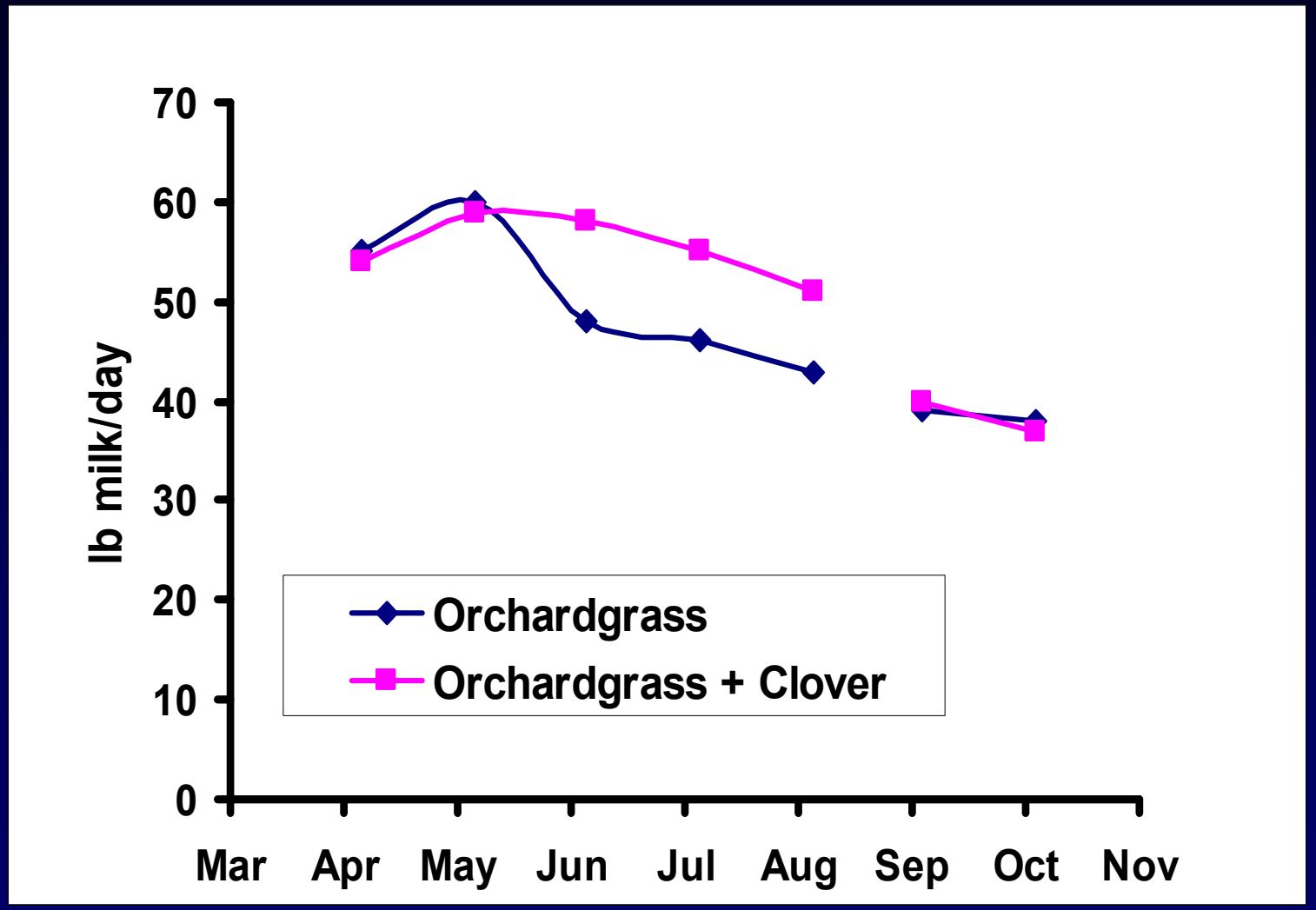
- Provide N
- Increase forage quality
  - Less fescue = less endophyte
  - Legume forage quality $\geq$ fescue
- Better yield distribution

Legume/Tall Fescue Mix



- Legumes:
- Start growth 2 weeks after CSG
- Deeper rooted species continue growth in summer
- Enhance CSG yield
- Enhance forage quality in spring

The Benefit of Legumes in Grass Pastures



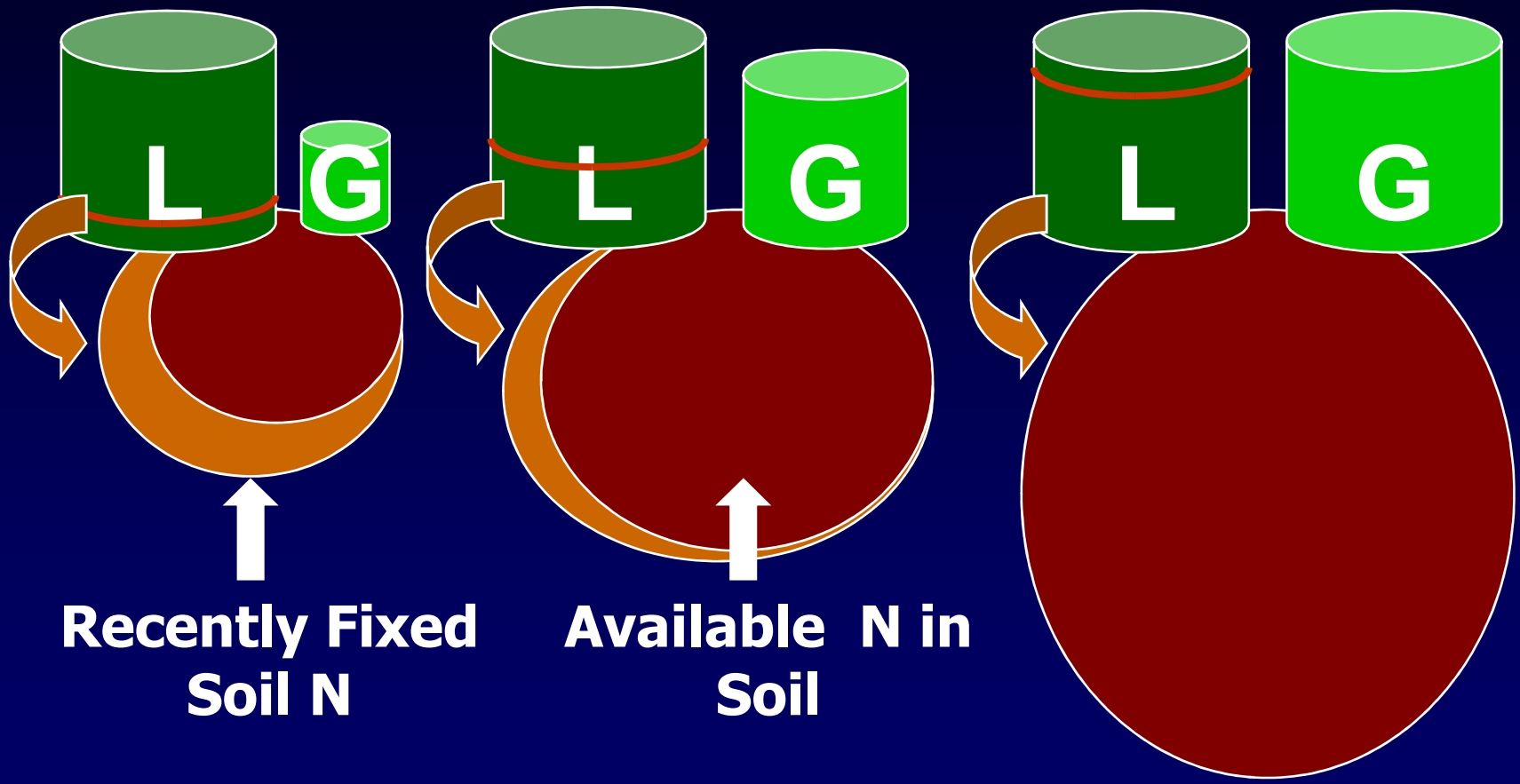
Virginia

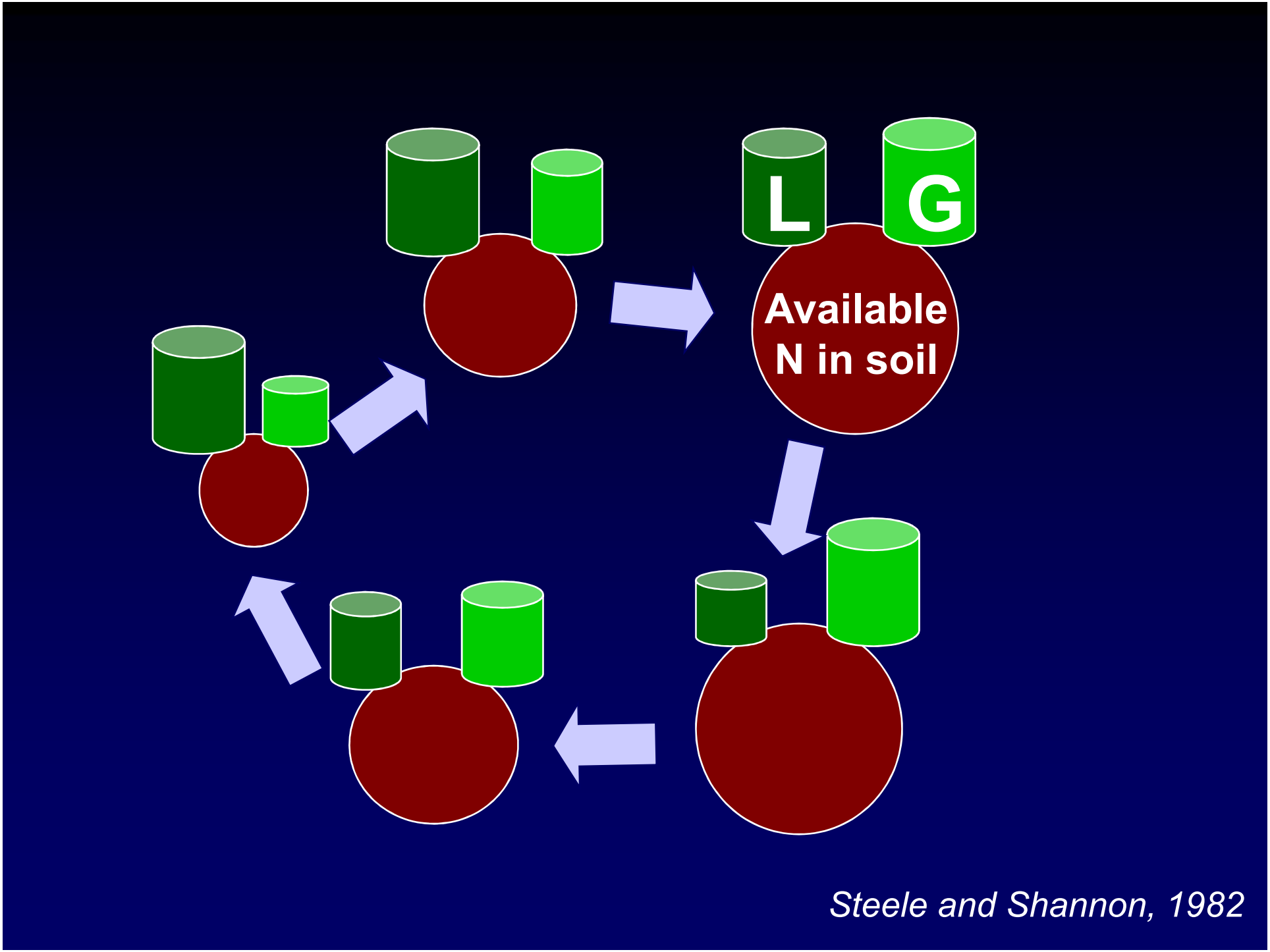
Transfer of Fixed N to Grass

- 10 - 50 lb. N/acre/yr
- 10 - 20% of the N fixed is transferred
- 10 - 50% of grass N is from legume

(West and Mallarino, 1996)

Legume/Grass Cycle



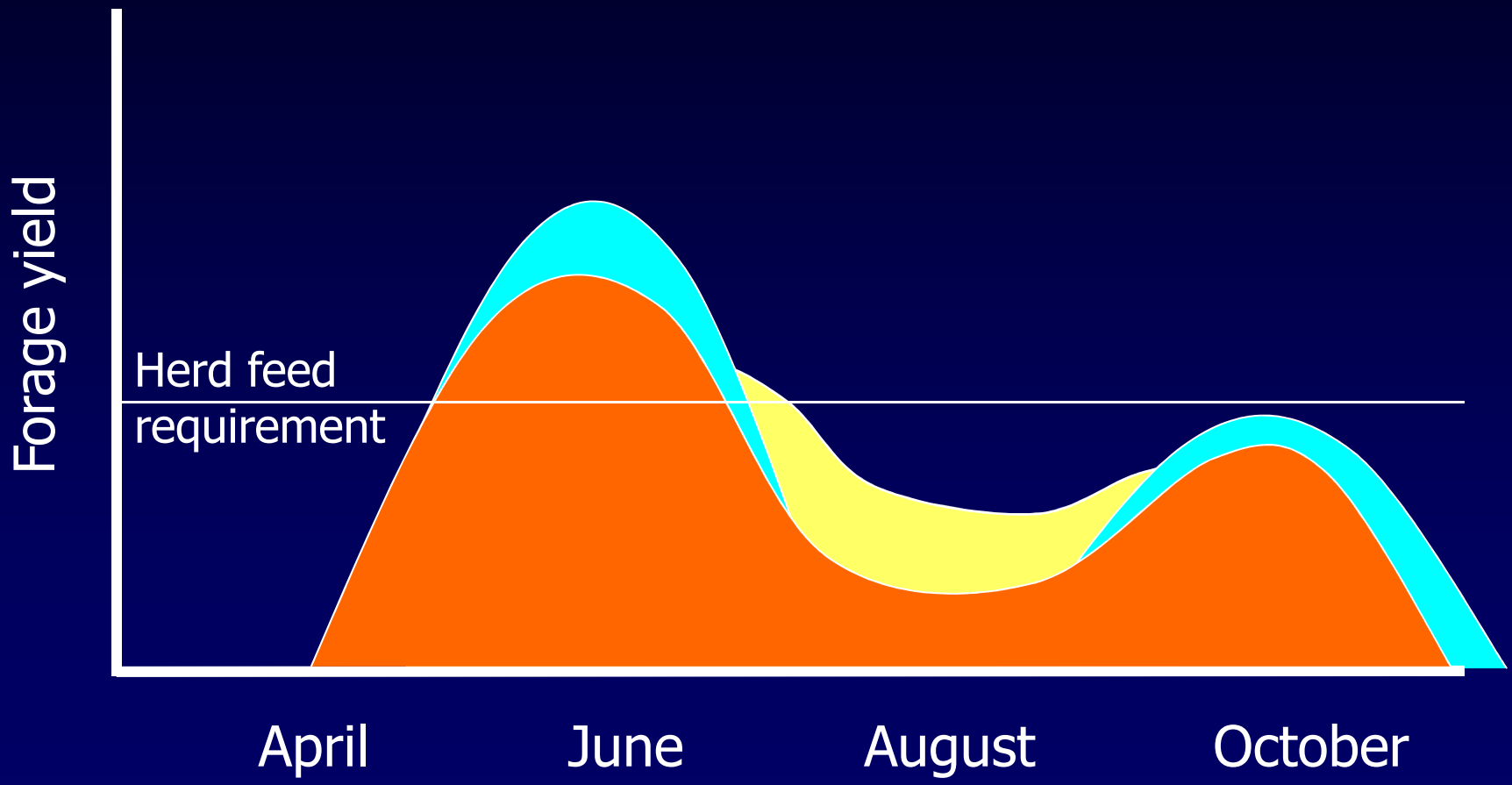


Steele and Shannon, 1982

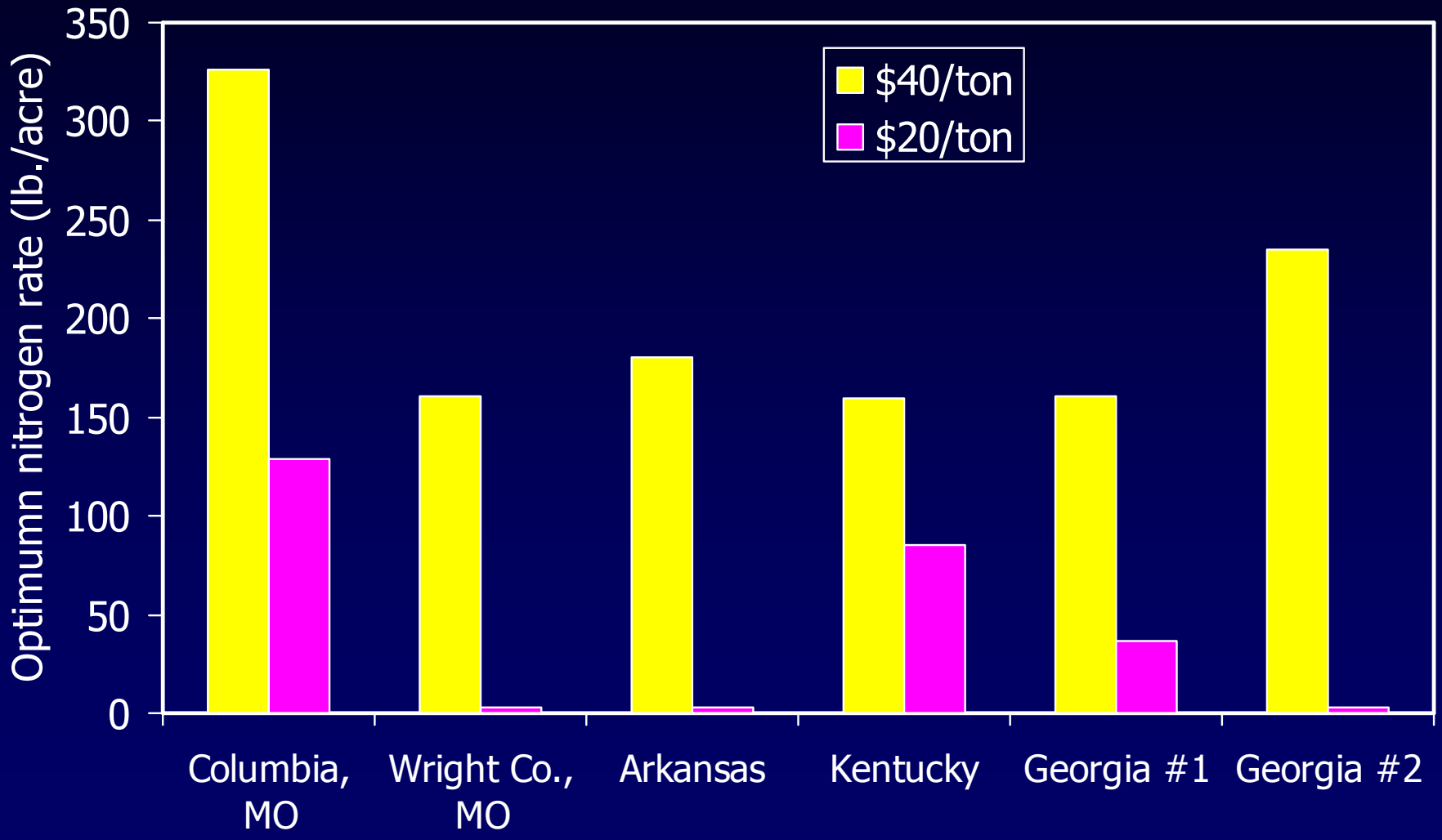
Nitrogen Fertilizer for Tall Fescue/Legume Mix

- N fertilizer increases grass growth – hurts legume
  - N fertilized grass smothers legume
  - Without fertilizer N grass growth limited, legume thrives on N fixation
  - Few studies show N response when legume exceeds 25% of stand (but that's a LOT of legume)
- If you use fertilizer N apply small amounts at times when legumes are dormant
  - Apply in early spring
  - August application less harmful to legume component
  - Harvest or graze in a timely fashion.

Legume/Tall Fescue Mix



Tall Fescue


Optimumn nitrogen rate (lb./acre)
350
300
250
200
150
100
50
0
$40/ton
$20/ton
Columbia, MO
Wright Co., MO
Arkansas
Kentucky
Georgia #1
Georgia #2

Should I Fertilize?

Depends on:

- Forage species
- Soil test levels
- Other limitations
- Forage value

Should I Fertilize?

- Fertilizing on a budget
  - Lime 1st, address Phosphorus (P) 2nd, Potassium (K) 3rd
  - Target very low and low testing soils
  - Moderate P levels ($\geq$20 lb. P_2O_5/acre) reduces grass tetany on fescue
  - Manure can be a excellent fertilizer

Maintenance Applications

- Grazing systems
  - Low P and K removal
  - Monitor with soil testing
- Nitrogen losses necessitate annual inputs
  - Maintain legumes in your pasture
  - Fertilizer or manure applications

Should I Fertilize?

- Grass/legume mixture
  - pH 6 - 7
  - P and K at least medium
  - No fertilizer N
- Spring vs. Fall N
  - Only apply spring N if you are short on spring pasture or are haying
  - Apply 40 - 60 lb./acre in August for stockpiling

Making Fertilizer Pay

- Fertilize when the plant has a capacity to respond
- Use fertilizer to increase forage at times when more forage is needed (summer, fall, winter)
- Maximize forage utilization (short grazing period)
- High performing animals and high prices make it easier to pay for fertilizer
- It is easier to make money with cheap fertilizer

Fertilizer Pays with Better Utilization

- Continuous grazed systems
  - 30% utilization of forage
  - Animals consume 600 lb. of every ton of forage
- Management intensive grazing (≥8 paddocks)
  - 50 to 70% utilization
  - Animals consume 1,000 to 1,400 lb. of every ton of forage

Making Fertility Pay on Pasture

- Use fertilizer to increase forage at times when more forage is needed--TIMING
- You are only paying for fertility if it allows you to **feed less hay** or **sell more beef/milk**.