

Fertility Management in Pastures

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A close-up photograph of a person's hands using a soil auger to take a sample from the ground. The person is wearing a blue watch on their left wrist. The background shows dark, rich soil.

Know Where You Stand Soil Testing Pays

Avoid potential nutrient deficiencies

Reveal possible causes for poor pasture or hay production

Save money \$\$\$

- Apply enough plant nutrients
- Avoid excessive expense

Decide if you are going to follow guidelines!

- Soil test recommendations are not directly tied to your economic situation

Jim McCann...

"I saved \$20,000 by spending \$270 on soil tests."

Soil Testing

Sampling Tools



Shovel or spade

Soil probe

Soil auger

Wood Bit



Obtaining a quality soil sample

- Sample every 3 to 4 years
- Cost Varies - \$15-35
- In a 20-acre field, there are 40 million pounds of soil. You send 1 pound to the lab.
- Bad Sample = Bad Decisions



Obtaining a quality soil sample

Sample 6-8 inches deep in the soil

- Take a uniform quantity of soil from each subsample
- If using a shovel dig a hole and slice off one side

After collecting 10-20 cores in a bucket - crumble the soil into small pieces and mix well.

Remove rocks, grass and sticks.

Place about a pint of soil in a soil sample box or zip-lock bag. Discard excess soil.

Label the box for future identification.



Caution

Avoid sampling soon after applying fertilizer, lime or manure.

- Best to wait 1 year; at least 4-6 months

Avoid sampling areas around watering points, shade trees, gravel roads and other known hot spots.

Avoid old manure piles.

Sample Timing

Samples taken monthly in same spot 3 years in a row

- Univ. of Illinois

Potassium Levels

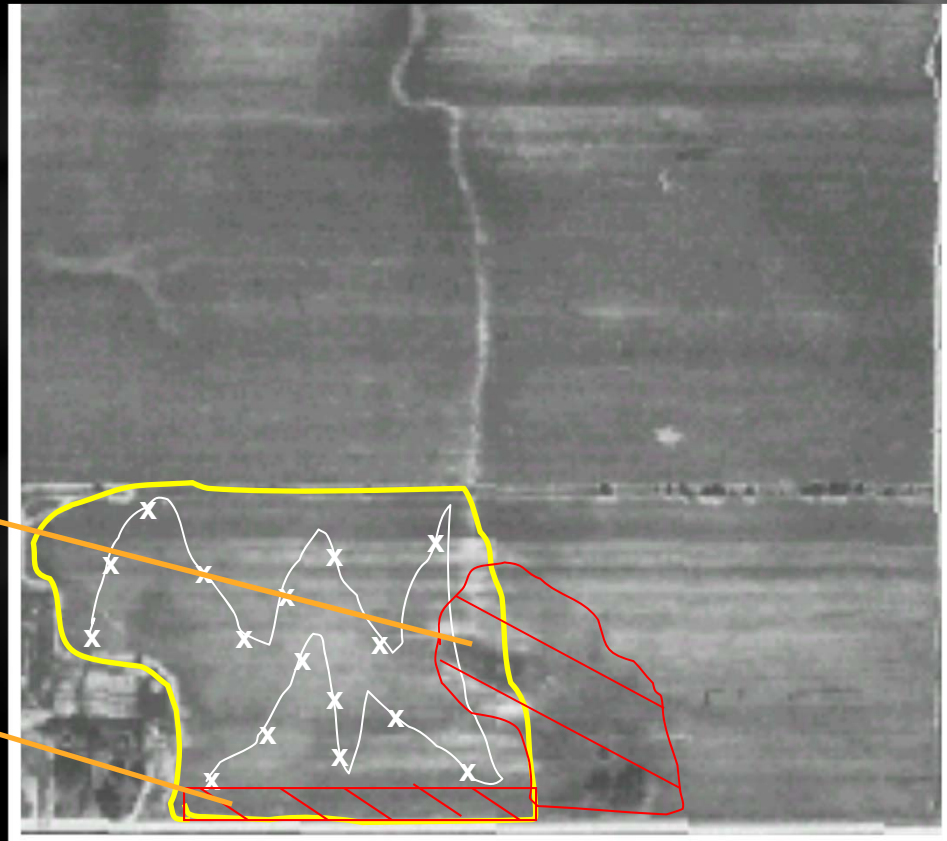
- highest March – June
- lowest August – September
- Varied from 310 – 140 lbs/acre

Potassium generally tests lower in dry conditions.



Obtain A Good Soil Sample

- 15 - 20 cores at random points along a zig-zag pattern in the field
- Avoid sampling near feeding areas and shade trees in pasture
- Avoid sampling near road





Soil Test Report

Soil Testing Laboratory
23 Mumford Hall, MU
Columbia, MO 65211
Phone: (573) 882-0623

or Soil Testing Laboratory
P.O. Box 160
Portageville, MO 63873
Phone: (573) 379-5431



FIELD INFORMATION			
Field ID	Sample no. 1	Serial no. _____ Lab no. _____	
Acres	Last Listed		Area _____ County _____ Region 3
	Irrigated		Submitted _____ Processed _____
Last crop			

This report is for:

Example Report
University of Missouri
Columbia, MO 65211

Soil sample submitted by:

B SOIL TEST INFORMATION	C RATING									
	Very low	Low	Medium	High	Very High	Excess				
pH (salt pH)	4.9	*****								
Phosphorus (P)	22 lbs/acre	*****								
Potassium (K)	303 lbs/acre	*****								
Calcium (Ca)	2091 lbs/acre	*****								
Magnesium (Mg)	278 lbs/acre	*****								
Sulfur (SO ₄ -S)	ppm									
Zinc (Zn)	ppm									
Manganese (Mn)	ppm									
Iron (Fe)	ppm									
Copper (Cu)	ppm									
Organic matter	%	Neutralizable acidity	meq/100g	Cation Exch. Capacity	12.8	meq/100g				
pH in water		Electrical Conductivity	mmho/cm	Sodium (Na)		lbs/a				
Nitrate (NO ₃ -N)	ppm	Topsoil	ppm	Subsoil	ppm	Sampling Depth	Top	Inches	Subsoil	Inches
E Cropping options	D	F Yield goal	G Pounds per acre					H LIMESTONE SUGGESTIONS		
			N	P ₂ O ₅	K ₂ O	Zn	S			
Alfalfa/Grass		0	20	55	0			Effective neutralizing material (ENM)	1,395	
Establishment		0	20	45	0					
Clover/Grass Establishment		6	0	90	235			Effective magnesium (EMg)		
Alfalfa/Grass Hay		150 CD/A	90	30	20					

I To determine limestone need in tons/acre, divide ENM requirements by the guarantee of your limestone dealer.

When N requirement for cool-season grass exceeds 90 lbs/acre, apply 2/3 of it during the period from December through February, and the remainder in August.

Do not use nitrogen on spring seedlings of legumes after May 1st because of potential weed competition.

Area Agronomy Specialist _____ Agronomy Specialist _____ Phone (573) 892-1000 _____
 White - Farmer, Yellow - ASCS, Blue - Firm, Pink - Extension MP 100 Revised 1/95 Signature _____

University of Missouri, Lincoln University, U.S. Department of Agriculture & Local University Extension Councils Cooperating
equal opportunity institutions

- A. Field info
- B. Soil test info
- C. Rating
- D. Nutrient requirements
- E. Cropping options
- F. Yield goal
- G. Pounds per acre
- H. Limestone suggestions
- I. Special notes





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Acres	Last Listed	Irrigated
Last crop		

A

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Magnesium (Mg) 278 lbs/acre	*****							
Sulfur (SO ₄ -S) ppm								
Zinc (Zn) ppm								
Manganese (Mn) ppm								
Iron (Fe) ppm								
Copper (Cu) ppm								
Organic matter %	Neutralizable acidity meq/100g		Cation Exch. Capacity 12.8 meq/100g					
pH in water	Electrical Conductivity mmho/cm		Sodium (Na) lbs/a					
Nitrate (NO ₃ -N) Topsoil ppm	Subsoil ppm	Sampling Depth Top		Inches Subsoil	Inches			
D NUTRIENT REQUIREMENTS			G			H LIMESTONE SUGGESTIONS		
E Cropping options	F Yield goal	Pounds per acre					Effective neutralizing material (ENM)	1,395
		N	P ₂ O ₅	K ₂ O	Zn	S		
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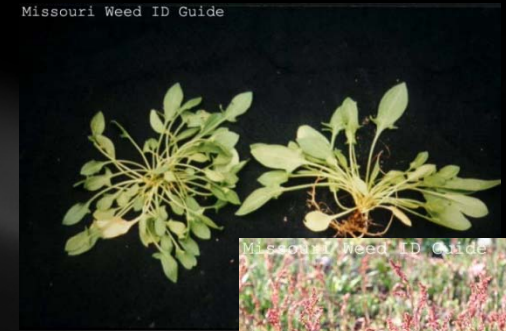
Area Agronomy Specialist Agronomy Specialist Phone (573) 892-1000
White - Farmer, Yellow - ASCS, Blue - Firm, Pink - Extension MP 100 Revised 1/95 Signature _____

Rating

- **Very Low**
Large buildup needed, limiting yield factor
- **Low**
Moderate buildup needed, probably limiting yield
- **Medium**
Slight buildup desired, not limiting yield yet
- **High**
No buildup needed, maintain
- **Very High**
Current buildup is adequate, no maintenance needed currently
- **Excess**
Sufficiently high, could cause an imbalance, use plant analysis to monitor nutrient needs

Low pH_s (below 5)

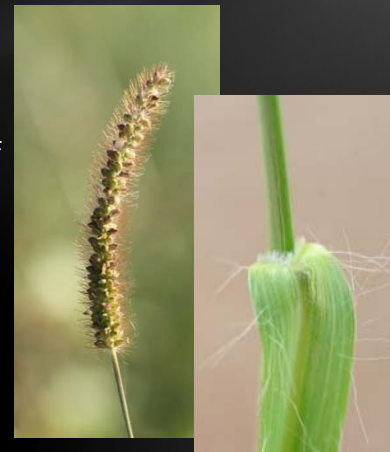
- **Increased aluminum solubility**
 - Stunted root growth
 - Reduced nutrient uptake
- **Reduced nutrient availability**
 - Phosphorous
- **Poor legume growth**
 - Survival and activity of N fixing bacteria reduced
 - Reduced success of the symbiosis



Red Sorrel is a weed indicator of low pH



Common and Lanceleaf Ragweed and Yellow Foxtail reduced with an increased pH



When pH increased by 1 unit, total weed density decreased <4,000 weeds/acre!
-Kevin Bradley



Cation Exchange Capacity (CEC)

- Measure of a soil's ability to hold positive charged ions
- Calculation of Ca^{++} Mg^{++} K^+ & H^+ tests
- Influences K and Mg recommendations
- The higher the CEC, the more cations a soil can retain
- Soils differ in CEC depending on clay and organic matter content
- Soil texture affects CEC
 - Soils with low CEC (1 to 10) have high sand content and low water-holding capacity. They require less lime to correct a given pH, and leaching of nitrogen and potassium is more likely.
 - Soils with high CEC (15 to 40) have high clay or humus content and high water-holding capacity. They require more lime to correct a given pH and have a greater capacity to hold nutrients.

Organic Matter (O.M.)

- Estimate potential N release over the growing season
- Provides a basis for determining proper rates of some herbicides
- Improves water holding capacity
- Major source of nutrients (N, P & S)

How Much Fertilizer do I Need?

 University Extension <small>UNIVERSITY OF MISSOURI COLUMBIA</small>		Soil Test Report		Soil Testing Laboratory 23 Mumford Hall, MU Columbia, MO 65211 Phone: (573) 882-0623		or Soil Testing Laboratory P.O. Box 160 Portageville, MO 63873 Phone: (573) 379-5431				
FIELD INFORMATION					Serial no. _____ Lab no. _____		Area _____ County _____ Region 3			
Field ID _____ Sample no. 1					A		Submitted _____ Processed _____		Soil sample submitted by: _____	
Acres _____ Last Limed _____		Irrigated _____		Last crop _____						
This report is for: Example Report University of Missouri Columbia, MO 65211										
B SOIL TEST INFORMATION					C RATING					
					Very low	Low	Medium	High	Very High	Excess
pH _s	(salt pH)	4.9			*****					
Phosphorus	(P)	22 lbs/acre			*****					
Potassium	(K)	303 lbs/acre			*****					
Calcium	(Ca)	2091 lbs/acre			*****					
Magnesium	(Mg)	278 lbs/acre			*****					
Sulfur	(SO ₄ -S)	ppm								
Zinc	(Zn)	ppm								
Manganese	(Mn)	ppm								
Iron	(Fe)	ppm								
Copper	(Cu)	ppm								
Organic matter	%	Neutralizable acidity	meq/100g	Cation Exch. Capacity	12.8	meq/100g				
pH in water		Electrical Conductivity	mmho/cm	Sodium (Na)		lbs/a				
Nitrate (NO ₃ -N)	Topsoil	ppm	Subsoil	ppm	Sampling Depth	Top	Inches	Subsoil	Inches	
D NUTRIENT REQUIREMENTS					E CROPPING OPTIONS					
					F YIELD GOAL					
					G POUNDS PER ACRE					
					H LIMESTONE SUGGESTIONS					
					N	P ₂ O ₅	K ₂ O	Zn	S	
Alfalfa/Grass					0	20	55	0		
Establishment					0	20	45	0		
Clover/Grass Establishment					5	0	90	235		
Alfalfa/Grass Hay					150	90	30	20		
					Effective neutralizing material (ENM) 1,395					
					Effective magnesium (EMg)					



Low Potassium



Dandelion is an indicator of low K

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

Signs

- Tip and margin burn on older leaves
- Weak stalks
- Small, shriveled seeds/fruit
- Slow growth

University Extension | **Soil Test Report** | Soil Testing Laboratory 23 Mansfield Hall, MU Columbia, MO 65211 | Phone: (573) 882-0623

Soil Testing Laboratory | P.O. Box 160 | Portageville, MO 65873 | Phone: (573) 379-5431

Serial no. Q36558-3 | Lab no. C0411836
County Jasper | Region 5
Submitted 9/10/2004 | Processed 9/24/2004
Soil sample submitted by: Firm Number: Outlet:

FIELD INFORMATION

Field ID	EAST SIDE	Sample no.	3
Acres	40	Last limed >5 yrs	Irigated No
Last crop	16 CLOVER/CL GRASS HAY	FSA Copy	N

This report is for:

SOIL TEST INFORMATION		RATING					
		Very Low	Low	Medium	High	Very High	Excess
pH _L (soil pH)	4.6	*****					
Phosphorus (P)	7 lbs/A	*****					
Potassium (K)	40 lbs/A	*****					
Calcium (Ca)	1582 lbs/A	*****	*****				
Magnesium (Mg)	53 lbs/A	*****					
Sulfur (SO ₄ -S)	ppm						
Zinc (Zn)	ppm						
Manganese (Mn)	ppm						
Iron (Fe)	ppm						
Copper (Cu)	ppm						
Organic matter	2.7	% Neutralizable acidity	4.0	meq/100g	Cation Exch. Capacity	8.2	meq/100g
PH in water		Electrical Conductivity		Mmho/cm	Sodium (Na)		Brs/A
Nitrate (NO ₃ -N) Topsoil	ppm	Subsoil	ppm	Sampling Depth	Top	Inches	Subsoil
				NUTRIENT REQUIREMENTS			
Cropping options		Yield goal	Pounds per acre				LIMESTONE SUGGESTIONS
16 CLOVER/CL GRASS HAY		200 CD/A	N	P ₂ O ₅	K ₂ O	S	
27 WARM SEASON GR PAST			0	90	265		Effective Neutralizing Material (ENM)
			60	40	90		Effective magnesium (EMg)
							75

Comments:
 ---Some herbicide labels list restrictions based on soil pH in water. This sample has an estimated pH in water of 5.1. Use this estimated pH in water as a guide. If you wish to have soil pH in water analyzed, contact your dealer or Extension specialist listed below.
 ---For warm season grass production, apply 60 lbs nitrogen per acre in early June.
 ---To determine limestone needed in tons/acre, divide your ENM requirement by the guarantee of your limestone dealer.
 ***Suggest using dolomitic limestone to increase magnesium in your soil. If dolomitic limestone is not available, under high management use a soluble source of magnesium fertilizer at a rate of 30 to 40 pounds Mg per acre.

Regional Agronomy Specialist: John Hobbs | Phone: 417-223-4775
 While, Fanna, Ye, Kow, PSA, Blue-Firm, Pinc, Extension | MP 189 | Revised 1/98
 University of Missouri, Lincoln University, U.S. Department of Agriculture & Local University Extension Councils Cooperating | Signature: _____ | Columbia
 Equal opportunity statement

Low Calcium

- Reduced plant vigor and rigidity
- Reduction of new growth



Blossom end rot is a sign of low calcium

Signs

- Tip burn on younger leaves
- Growing point dieback. Death of growing point
- Stunted root growth
- Water soaked discoloration

Low Magnesium

- **Poor Photosynthesis**
- **Slow growth**



Signs

- Yellowing between veins of older leaves
- Yellowing at margins
- Upward curling of leaves



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Phone: (573) 379-5431



FIELD INFORMATION		
Field ID	Sample no. <u>1</u>	
Acres	Last Lined	Irrigated
Last crop		

A

Serial no.		Lab no.	
Area	County	Region <u>3</u>	
Submitted		Processed	

Soil sample submitted by:

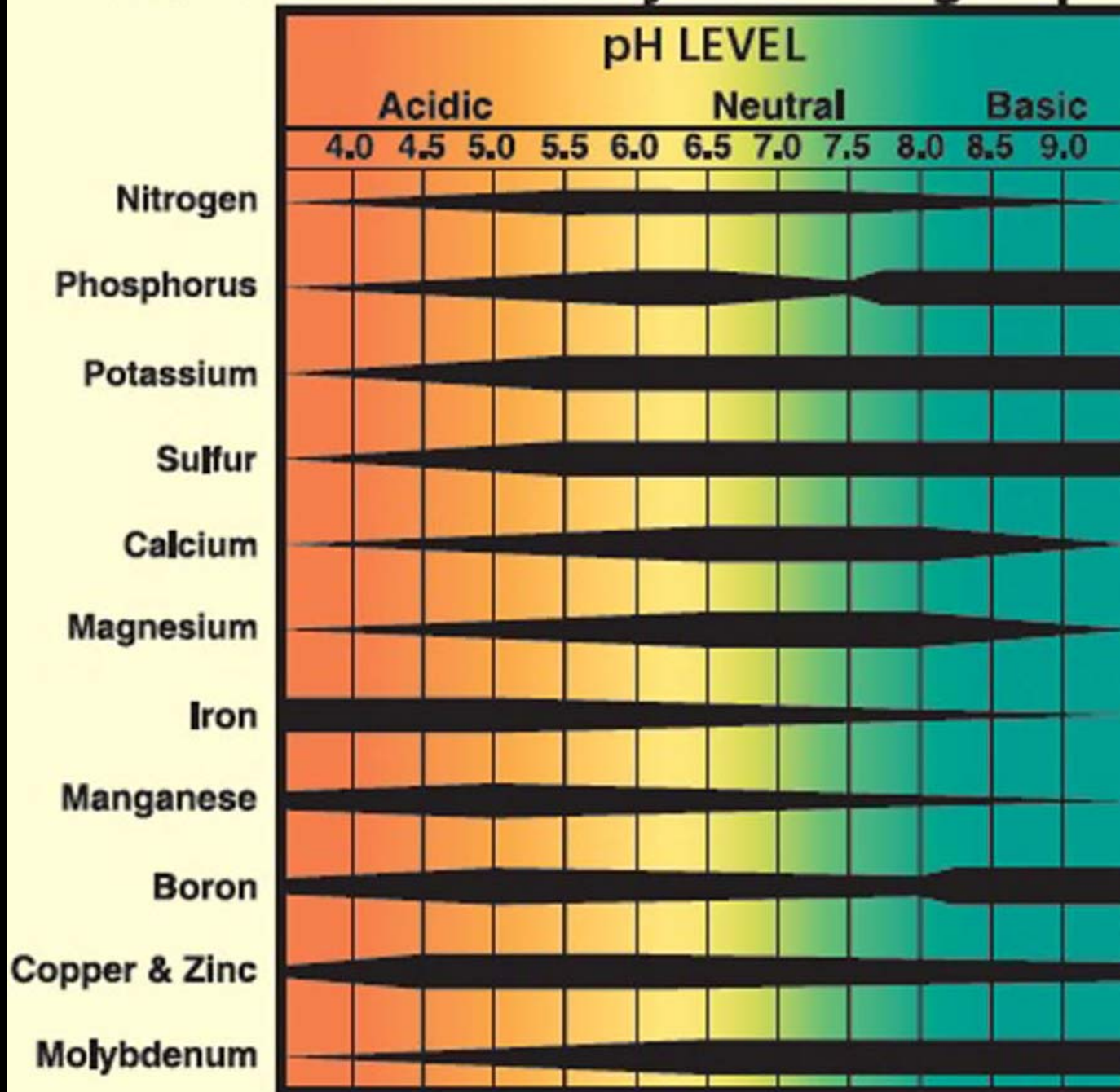
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Calcium	(Ca) <u>2091 lbs/acre</u>	*****								
Magnesium	(Mg) <u>278 lbs/acre</u>	*****								
Sulfur	(SO ₄ -S) ppm									
Zinc	(Zn) ppm									
Manganese	(Mn) ppm									
Iron	(Fe) ppm									
Copper	(Cu) ppm									
Organic matter	%	Neutralizable acidity	meq/100g	Cation Exch. Capacity		12.8	meq/100g			
pH in water		Electrical Conductivity		mmho/cm	Sodium (Na) lbs/a					
Nitrate (NO ₃ -N)	Topsoil ppm	Subsoil ppm	Sampling Depth		Top	Inches	Subsoil inches			
E Cropping options		D	F Yield goal	G Pounds per acre					H LIMESTONE SUGGESTIONS	
				N	P ₂ O ₅	K ₂ O	Zn	S		
Alfalfa/Grass		0		20	55	0			Effective neutralizing material (ENM)	1,395
Establishment		0		20	45	0			Effective magnesium (EMg)	
Clover/Grass Establishment		6		0	80	235				
Alfalfa/Grass Hay		150 CD/A		90	30	20				



Nutrient Availability According to pH



Limestone Puts Nutrients to Work

Percent Nutrient Availability

pH (salt)	Nitrogen %	Phosphorus %	Potassium %
4.0	30	23	33
4.5	53	34	52
5.0	77	48	77
5.5	89	52	100
6.5	100	100	100

Lime Provides the Basis for Fertility

Lime is the most economical amendment to apply
Limestone (Calcium Carbonate)

ENM (Effective Neutralizable Material) rates
limestone's effectiveness


- Smaller the particle size, the faster the action (higher ENM)
- No more than 2-3 tons per acre per year
- Sources: Ag Lime (~400-700 ENM); Dolomitic Lime (Mg source)



Ag Lime

Effective Neutralizing Material (ENM)

- To determine the amount of limestone needed in tons per acre, divide the ENM value on the soil report by the ENM guaranteed by your ag lime dealer
- <http://aes.missouri.edu/pfcs/aglime/index.stm>



LIMESTONE SUGGESTIONS	
Effective neutralizing material (ENM)	1,395
Effective magnesium (EMg)	-

EXAMPLE: If the soil test ENM requirement is 1395 and the lime quarry guarantee is 420 pounds ENM per ton of limestone, then you will need 3.3 tons of limestone per acre ($1395 \div 420$).



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Last crop		

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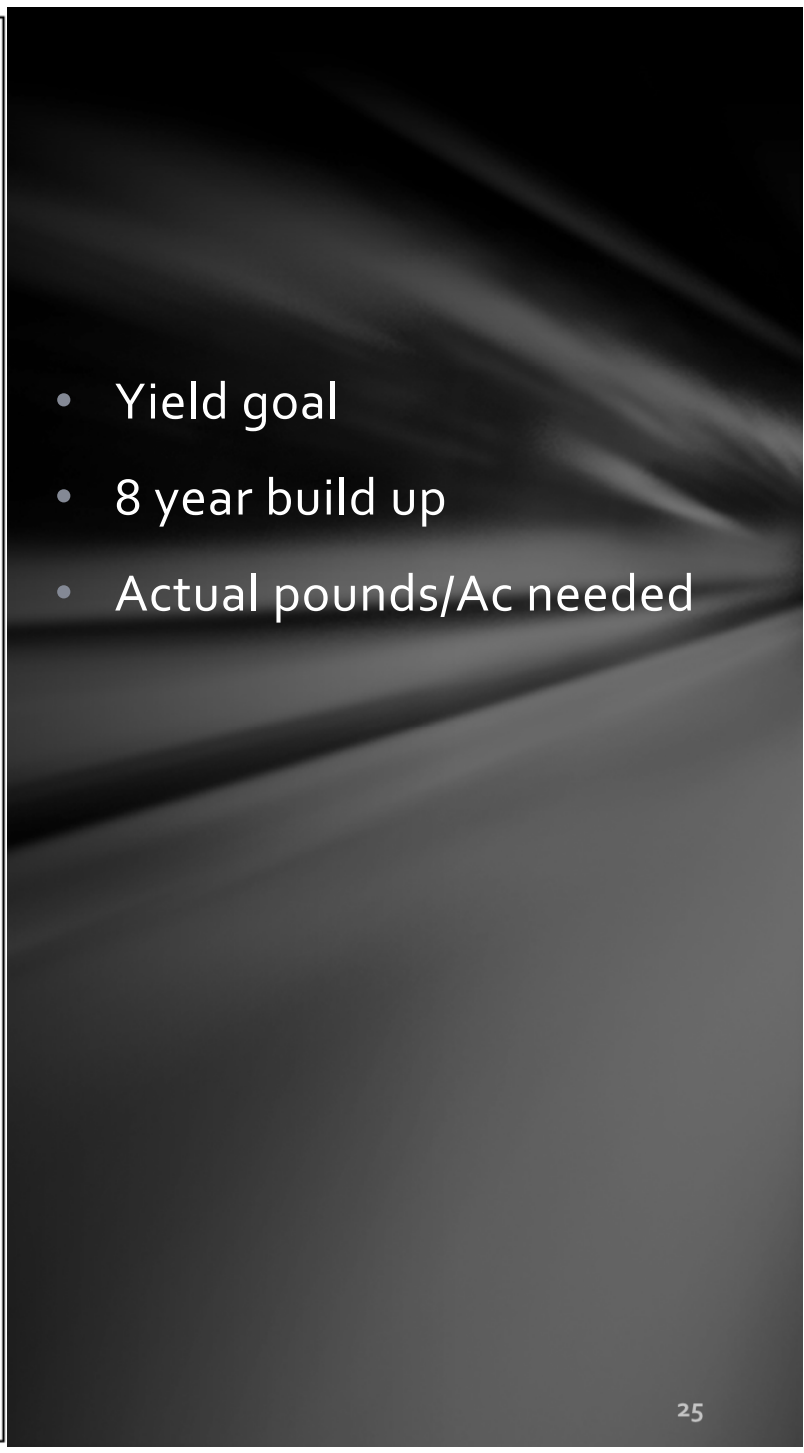
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Sulfur (SO ₄ -S) ppm						
Zinc (Zn) ppm						
Manganese (Mn) ppm						
Iron (Fe) ppm						
Copper (Cu) ppm						
Organic matter %	Neutralizable acidity meq/100g	Cation Exch. Capacity 12.8 meq/100g				
pH in water	Electrical Conductivity	mmhos/cm	Sodium (Na) lbs/a			
Nitrate (NO ₃ -N) Topsoil ppm	Subsoil ppm	Sampling Depth Top	Inches	Subsoil	Inches	

E Cropping options	D Yield goal	G Pounds per acre					H LIMESTONE SUGGESTIONS
		N	P ₂ O ₅	K ₂ O	Zn	S	
Alfalfa/Grass Establishment	0	20	55	0			Effective neutralizing material (ENM) 1,395
Clover/Grass Establishment	0	20	45	0			Effective magnesium (EMg)
Alfalfa/Grass Hay	150 CD/A	90	30	20			

I To determine limestone need in tons/acre, divide ENM requirements by the guarantee of your limestone dealer.

When N requirement for cool-season grass exceeds 90 lbs/acre, apply 2/3 of it during the period from December through February, and the remainder in August.

Do not use nitrogen on spring seedlings of legumes after May 1st because of potential weed competition.



- Yield goal
- 8 year build up
- Actual pounds/Ac needed

Fertilizer Fact!!

To produce 1 ton of forage

- 35 - 60 lbs of Nitrogen
- 12 - 15 lbs P_2O_5
- 45 - 60 lbs K_2O



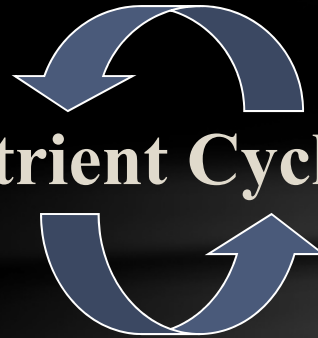


Hay System

Inputs

- fertilizer
- manure
- legumes (N)

Nutrient Cycle



Exports

- remove 80% of nutrients in hay

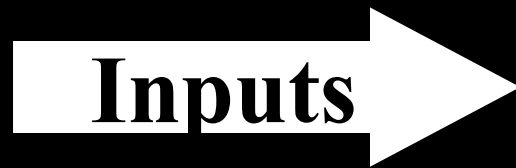
3 tons of hay remove:

- 120 lb. nitrogen
- 27 lb. P_2O_5
- 102 lb. K_2O

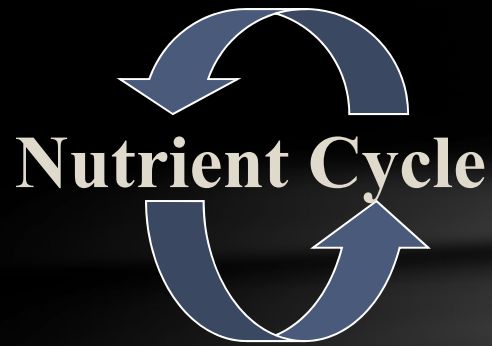




Pasture System



- fertilizer
- manure
- legumes (N)
- feed



- calves
- beef

Cow/calf pair, stocker removal rates

- 10 lb. nitrogen
- 7 lb. P_2O_5
- 1 lb. K_2O

Phosphorus Cycle

Pasture system



P from forage consumed per year	29 lb. P
Retained	— 3

Excreted	26 lb. P
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Efficiency
90 % returned



Per Cow-Calf Pair

Nitrogen Cycle

Pasture system



Forage	280 lb. N
— Retained	10

— Excreted	270
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Volatilization	70 to 135
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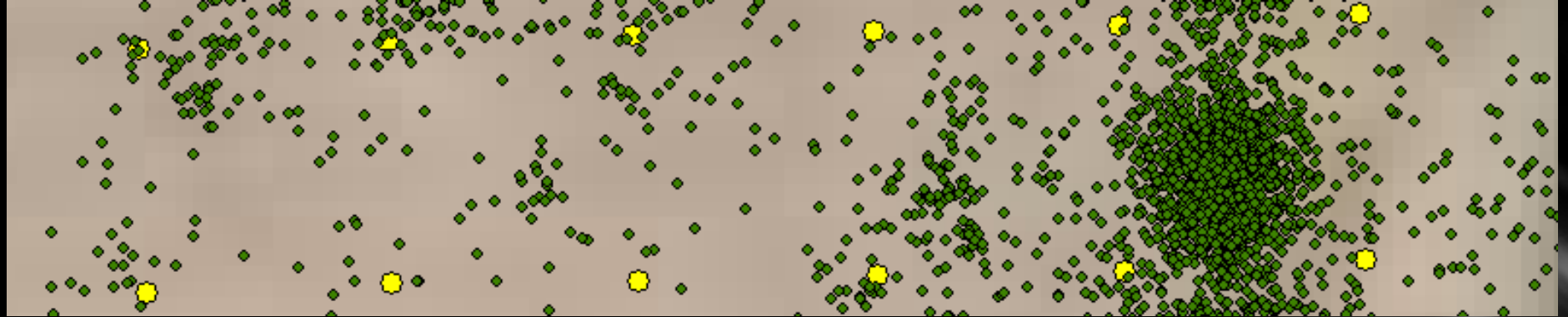
Returned	200 to 135lb. N
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Efficiency

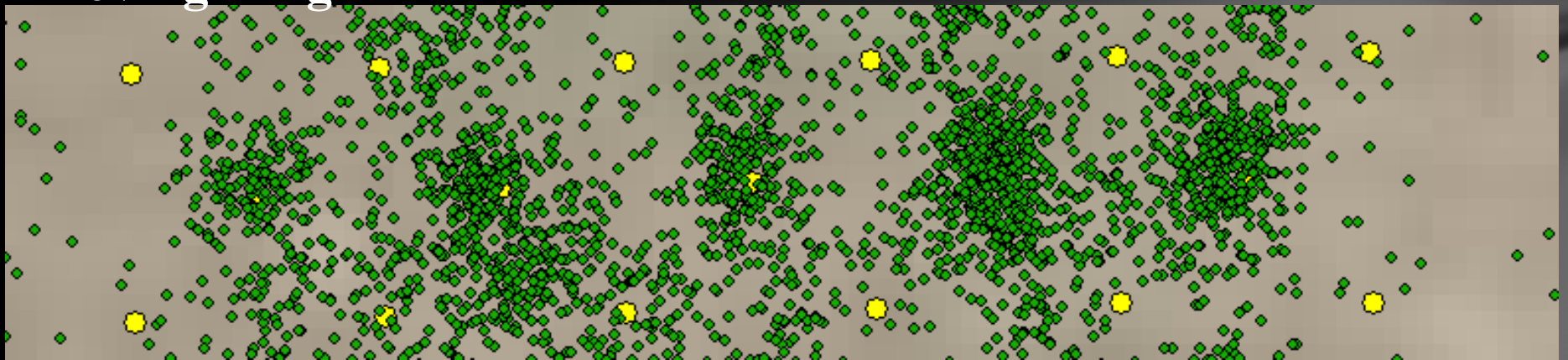
50 to 70 % returned

Per Cow-Calf Pair

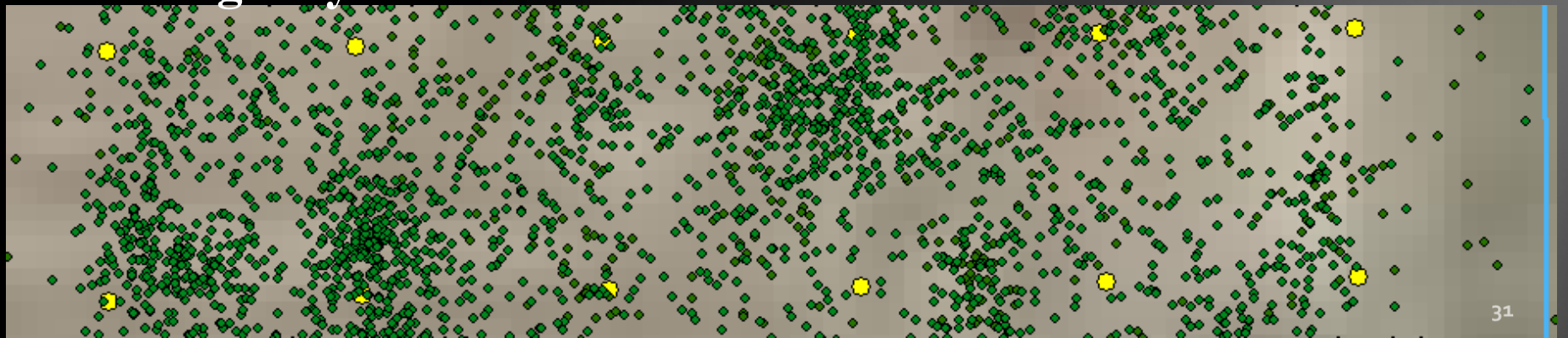
Stationary Ring



Moving Ring



Unrolling Hay



Tips for Fertilizing on a Budget

1. Take a soil test
 - You cannot manage what you don't measure
 - Helps to determine where to spend your money



2. Lime First

“The poor man’s fertilizer”

For cool-season grass:

- 5.5 to 7.0

For legumes:

- 6.0 to 7.5

Limit application to 2 to 3 ton/acre/year

Applying 2 ton/ac every now and then is NOT a good practice

Crop	P Removal (lbs/unit)	K Removal (lbs/unit)	P Removed Per Crop (lbs)	K Removed Per Crop (lbs)
Corn (150 bu)	0.45	0.30	68	45
Corn Silage (20 ton)	3.6	9	72	180
Soybeans (60 bu)	0.84	1.44	50	86
Wheat (70 bu)	0.60	0.30	42	21
Alfalfa (5 ton)	10	45	50	225
Fescue (2.5 ton)	9	34	23	85
Fescue / Clover (2.5 ton)	8	38	20	95
Bermudagrass (4 ton)	9	34	36	136
Native Warm Season Grasses (3.5 ton)	2	15	7	53

University of Missouri Extension – Tim Schnakenberg Regional Agronomy Specialist

Am I Fertilizing a Crop of Weeds?

If a high percentage of the foliage in pastures are weeds, don't give them an edge with fertilizer.

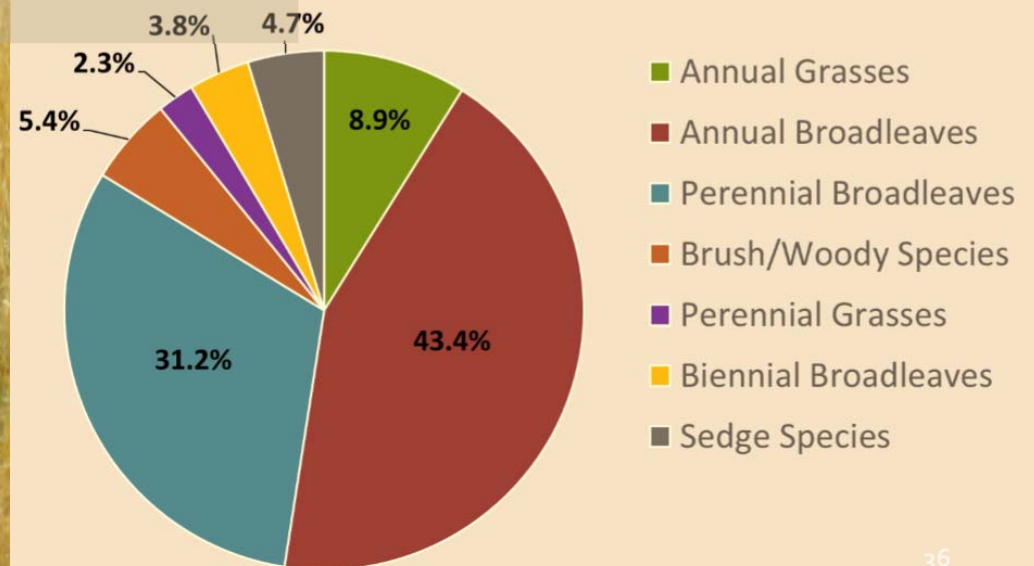
Decide whether to fertilize, spray or do both



Consequences of Foregoing Fertilizer

- Reduced forage production
- Reduced forage quality
- Reduced persistence of desirable species
- Excessive weeds and brush
- Dependent on expensive fertilizer N

Predominant Weed Types in Missouri Pastures



Fertilizer Fact!!

- Each 0.1 ppm unit increase in P and K corresponded to 162 and 12 fewer weeds per acre, respectively
- A 1-unit increase in soil pH corresponded to ~4,100 fewer weeds per acre

Influence of Select Soil and Forage Properties on Weed Density in Missouri Pastures

Parameters	Change in Total Weed Density per acre for each unit Increase in Selected Parameter
Soil pH	- 4,168
Forage Groundcover	- 283
Manganese	243
Sulfur	162
Phosphorus	- 162
Zinc	- 162
Potassium	- 12
Magnesium	- 8
Calcium	- 4

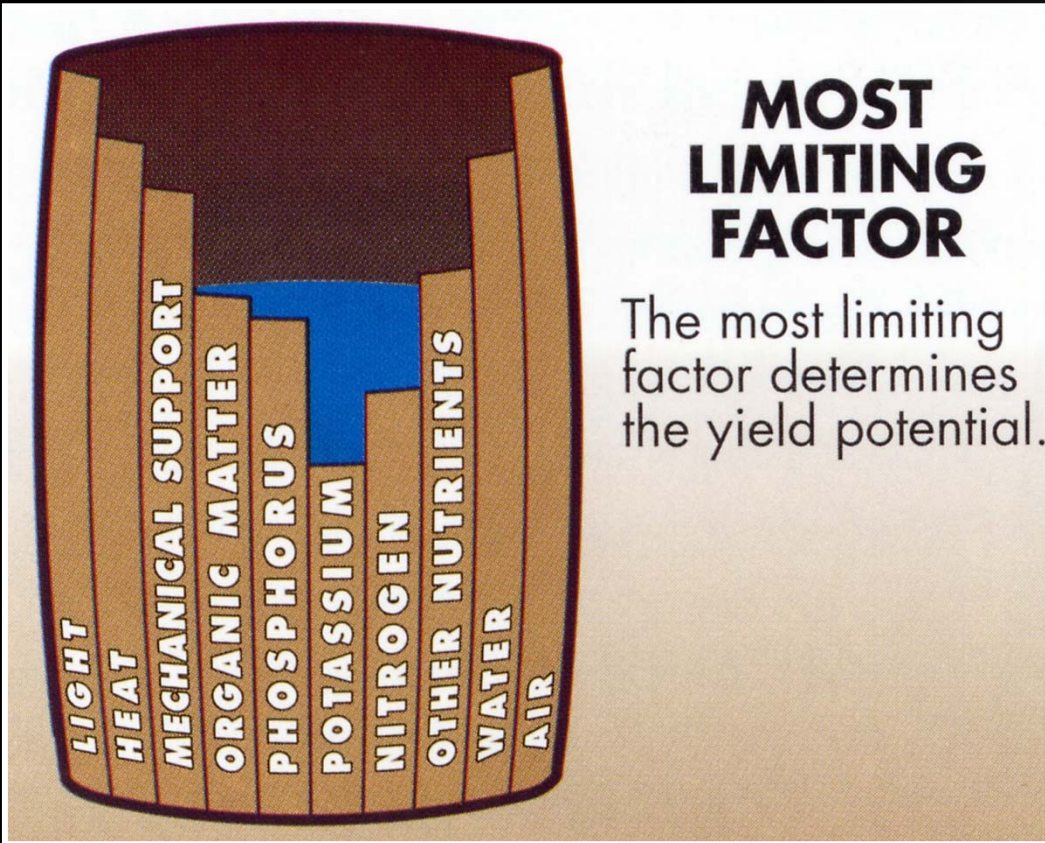
*O.M. and forage groundcover represented as %, soil pH in 1.0-unit increments, and Ca, K, Mg, Mn, P, S, and Zn as 1-ppm.

3. Target Low Testing Soils First

Soils that test low to very low will respond to increased fertility faster than soils testing medium or better



RATING						Probability of response to fertilizer
Very low	Low	Medium	High	Very high	Excess	
*****						very high
*****						high
*****						medium
*****						low
*****						none
*****						none



Soil Test Level for Persistence

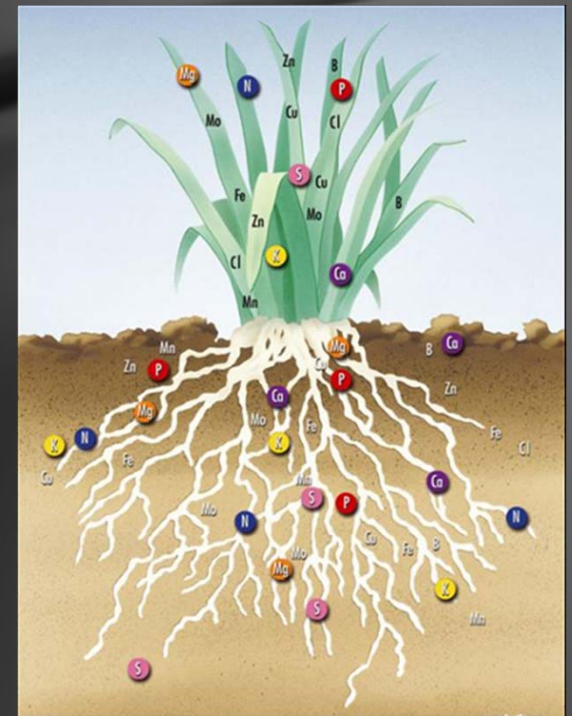
Forage	Very low	Low	Medium	High
Alfalfa				████████████████████
Annual Lespedeza		████████████████████	████████████████████	████████████████████
Birdsfoot Trefoil			████████████████████	████████████████████
Red Clover				████████████████████
White Clover			████████████████████	████████████████████
Cool-Season Grass	████████████████████	████████████████████	████████████████████	████████████████████
Warm-Season Grass		████████████████████	████████████████████	████████████████████

4. Fertilize at the Right Time

Phosphorus, Potassium, and Sulfur can be applied anytime during the growing season

best in the fall though

These nutrients are stable when in the soil and are less likely to move off site

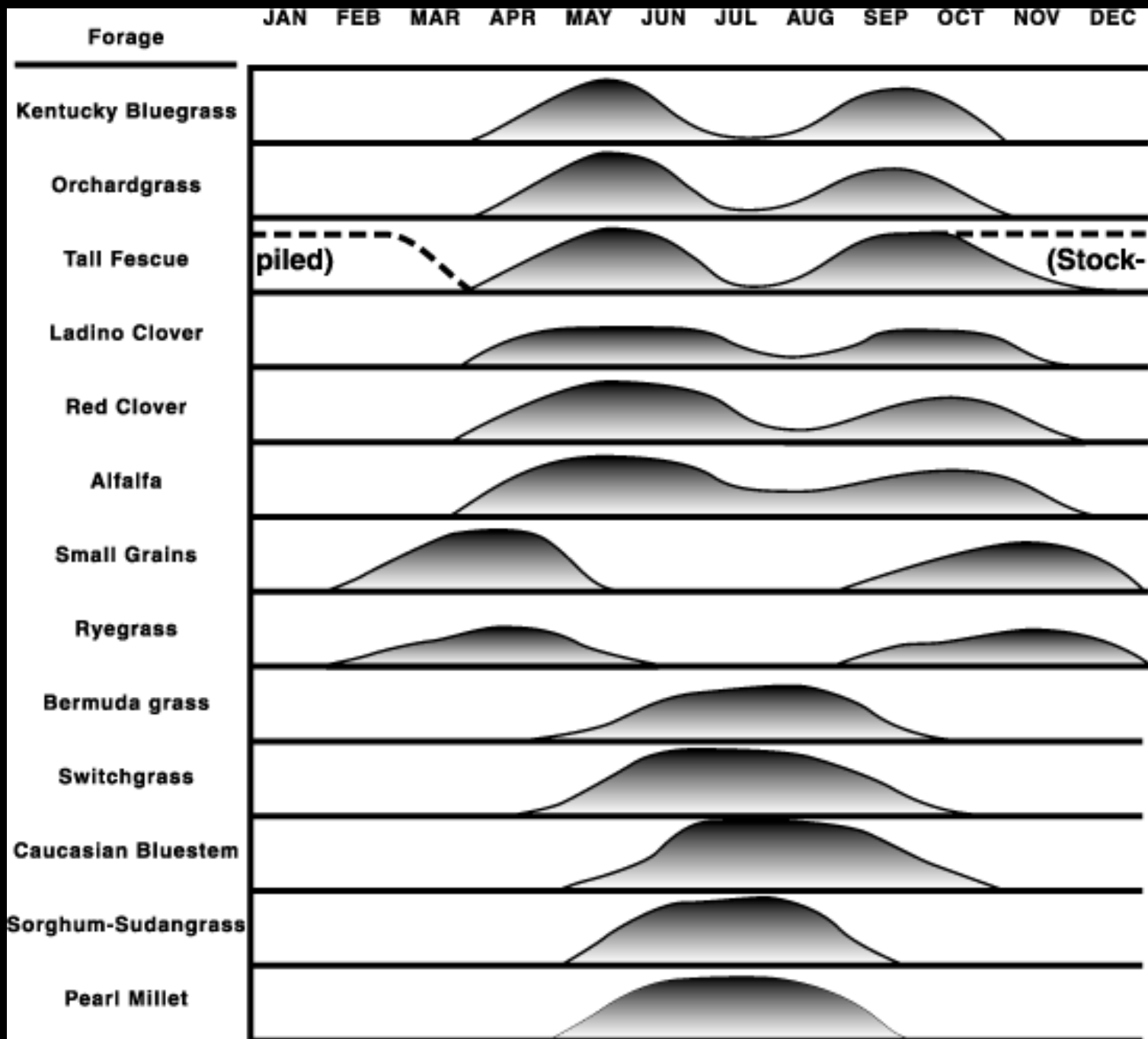


Fertility Management

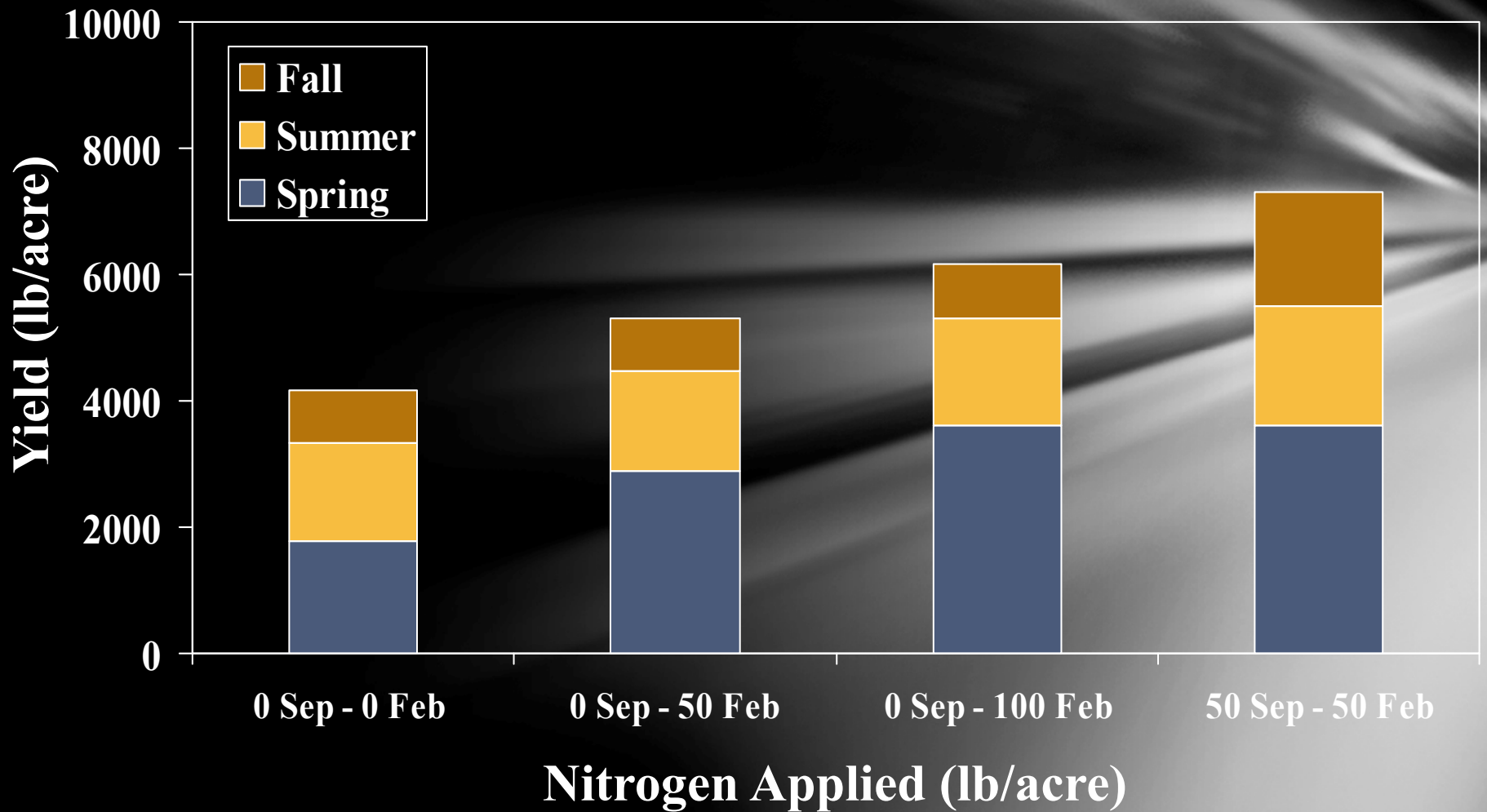
Nitrogen should be applied when the plant has the ability to respond

- This nutrient is mobile and has the ability to move away from the plants root zone



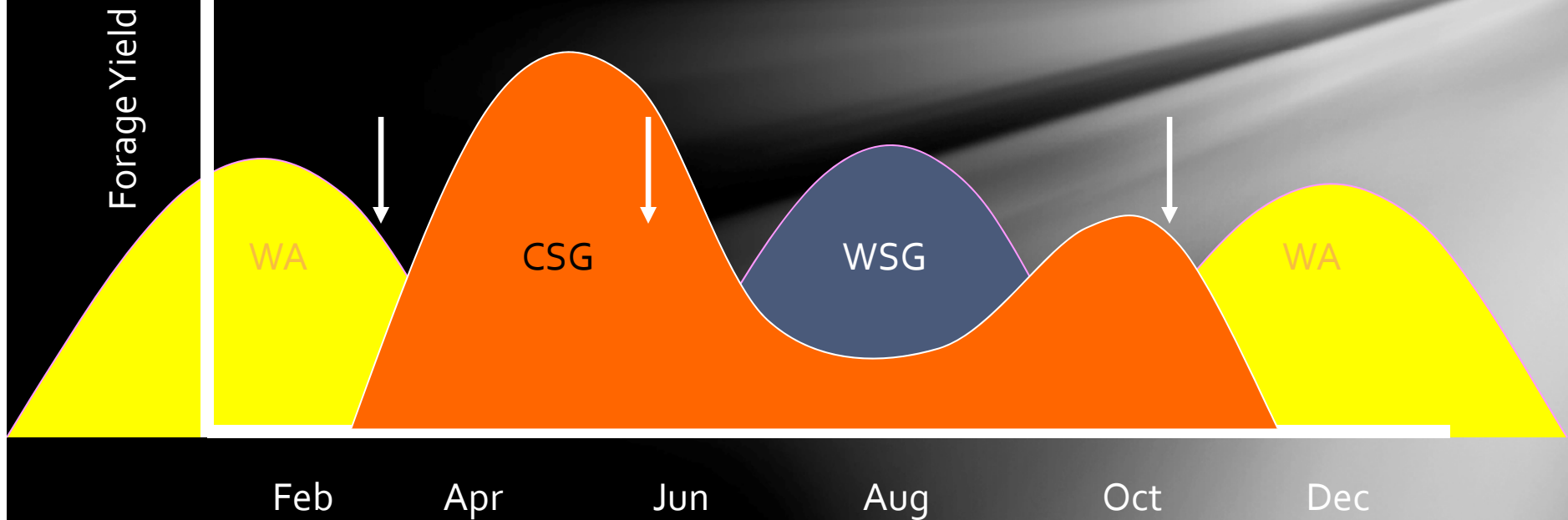


Fertilization of Tall Fescue



Use nitrogen fertilizer to increase forage at times when more forage is needed

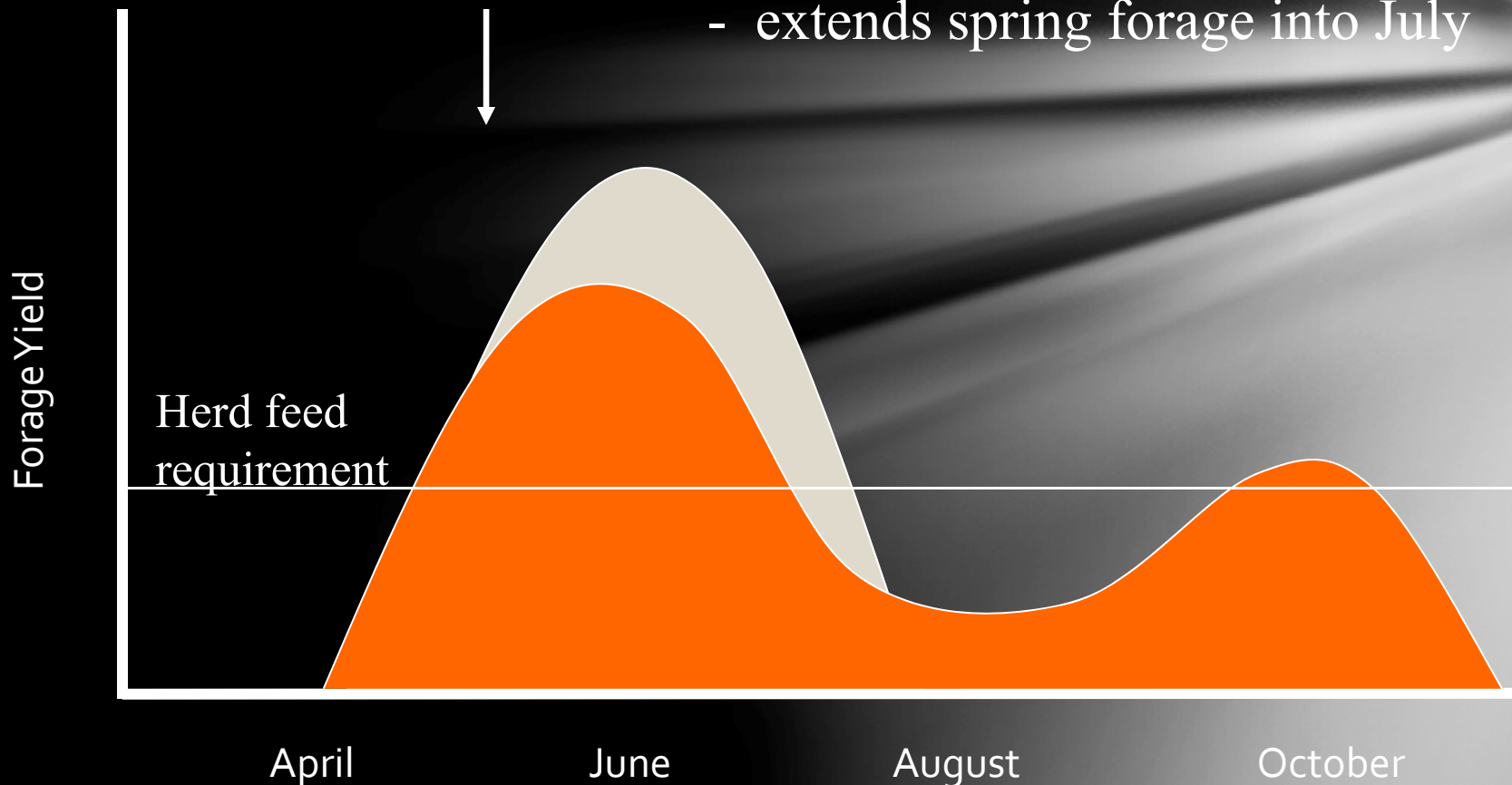
CSG - Cool season grass
WSG - Warm season grass
WA - Winter annual



Nitrogen for Tall Fescue Spring Pasture

Spring fertilization for Pasture:

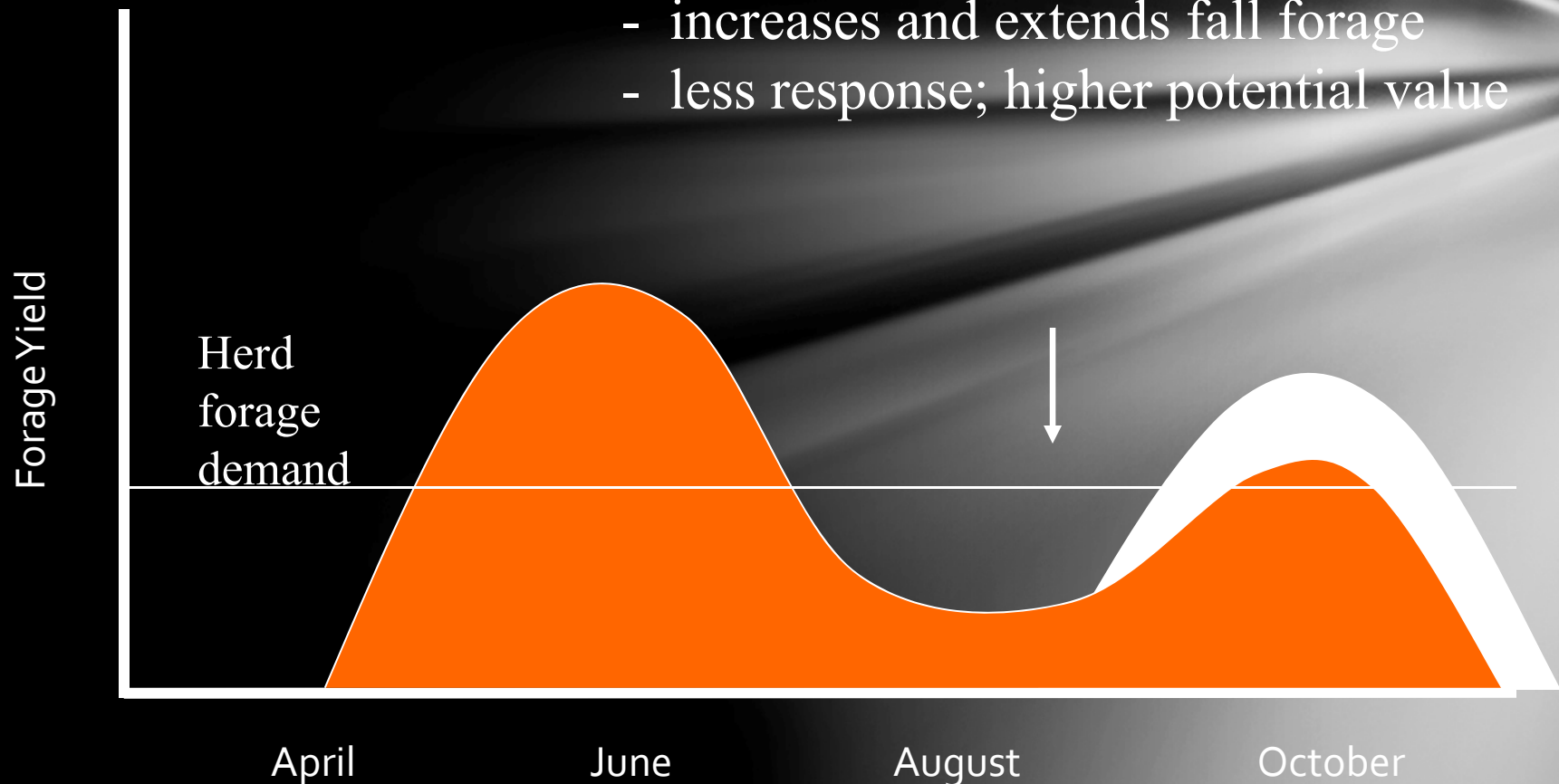
- apply nitrogen in early May
- extends spring forage into July



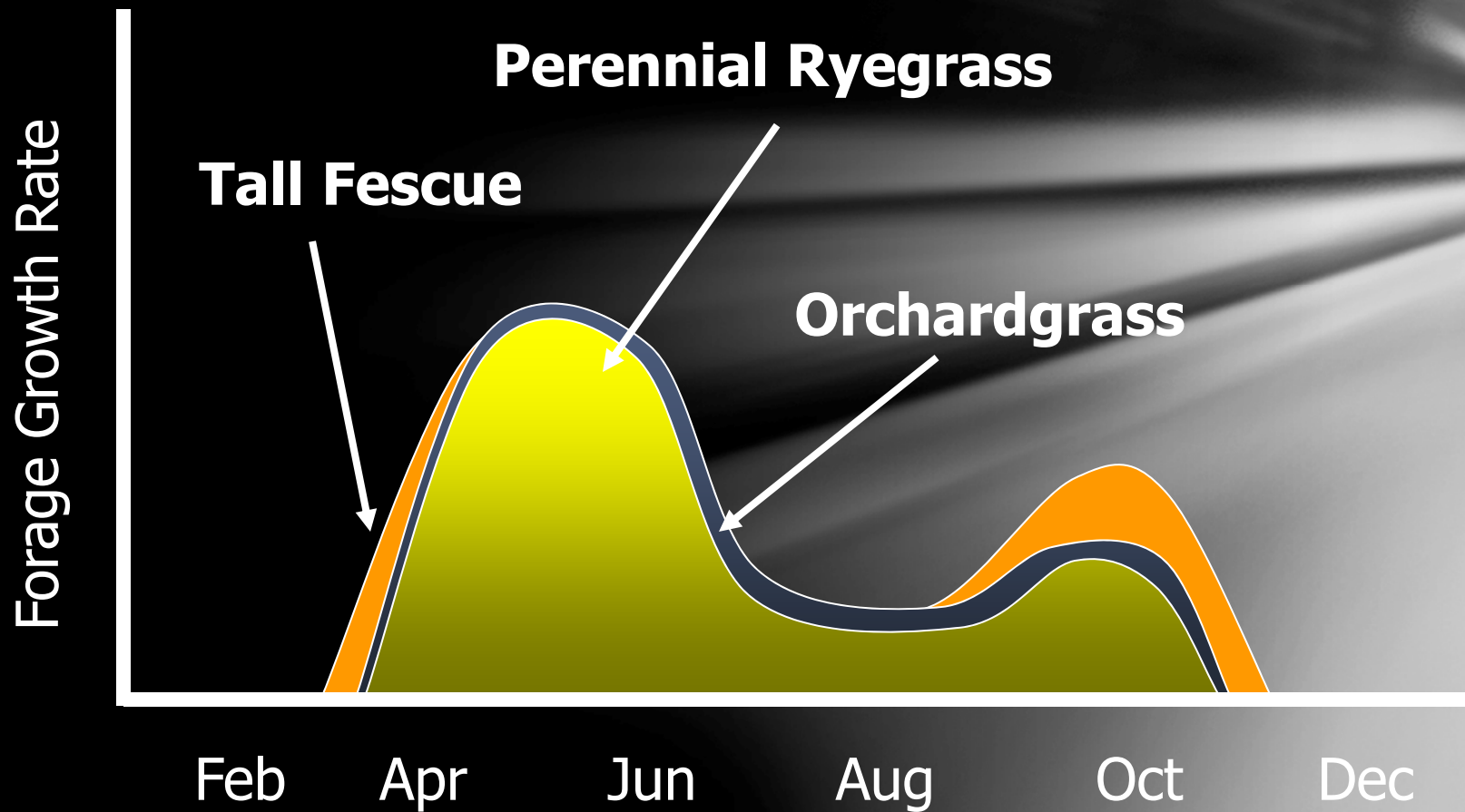
Nitrogen for Tall Fescue Fall Pasture

Fall fertilization for Pasture:

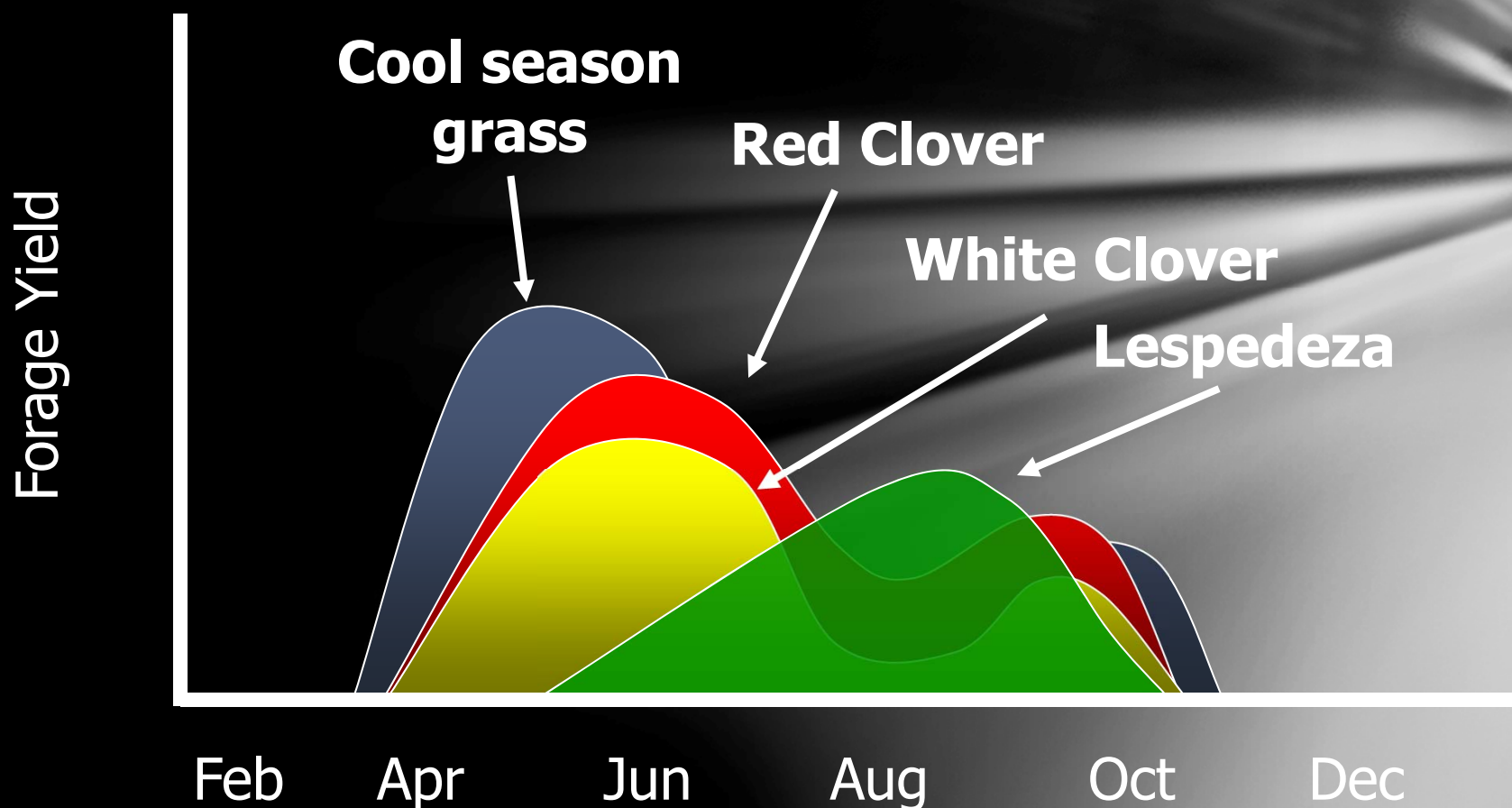
- apply nitrogen in mid August
- increases and extends fall forage
- less response; higher potential value



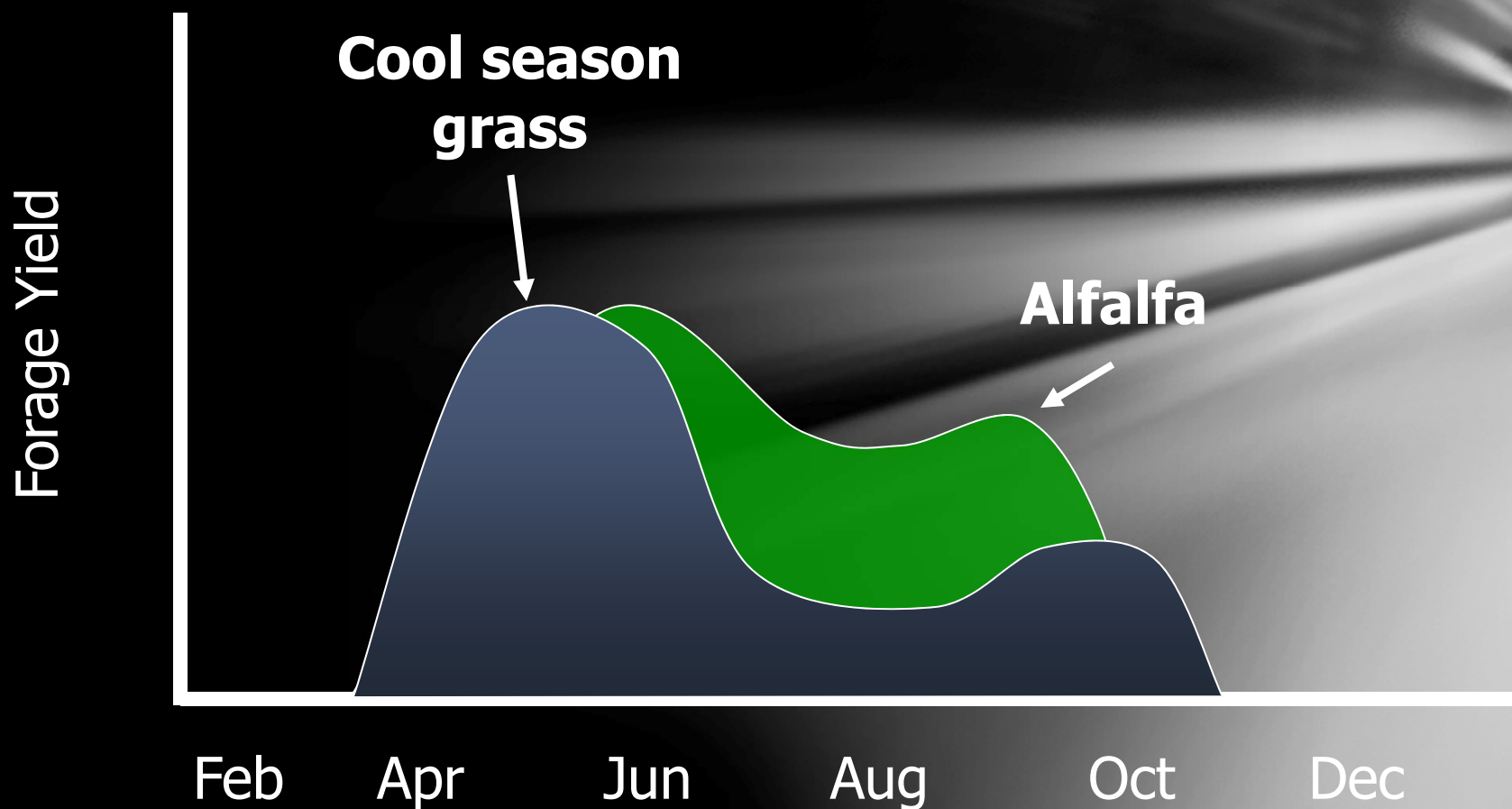
Cool Season Grasses



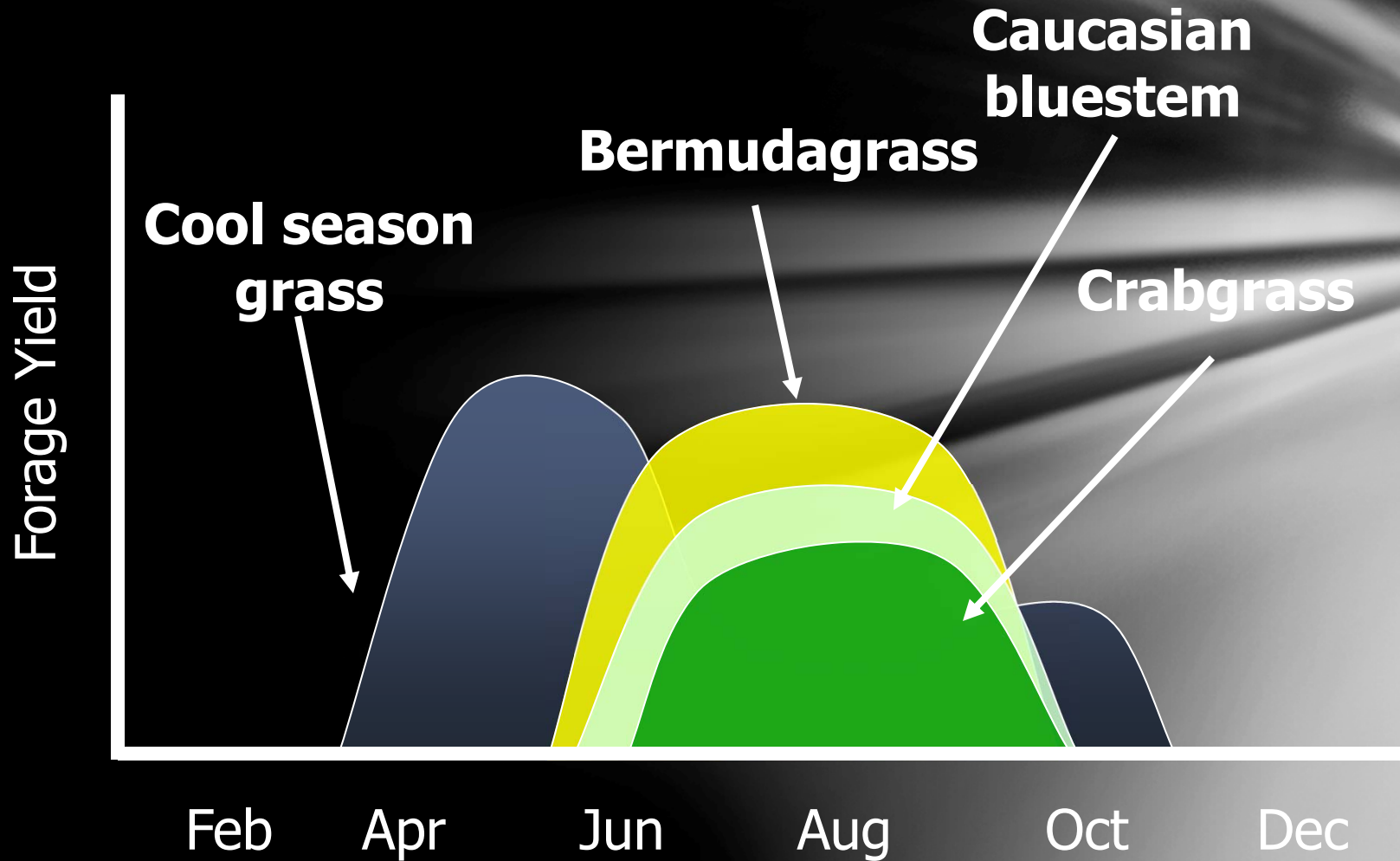
Cool Season Grass with Legumes



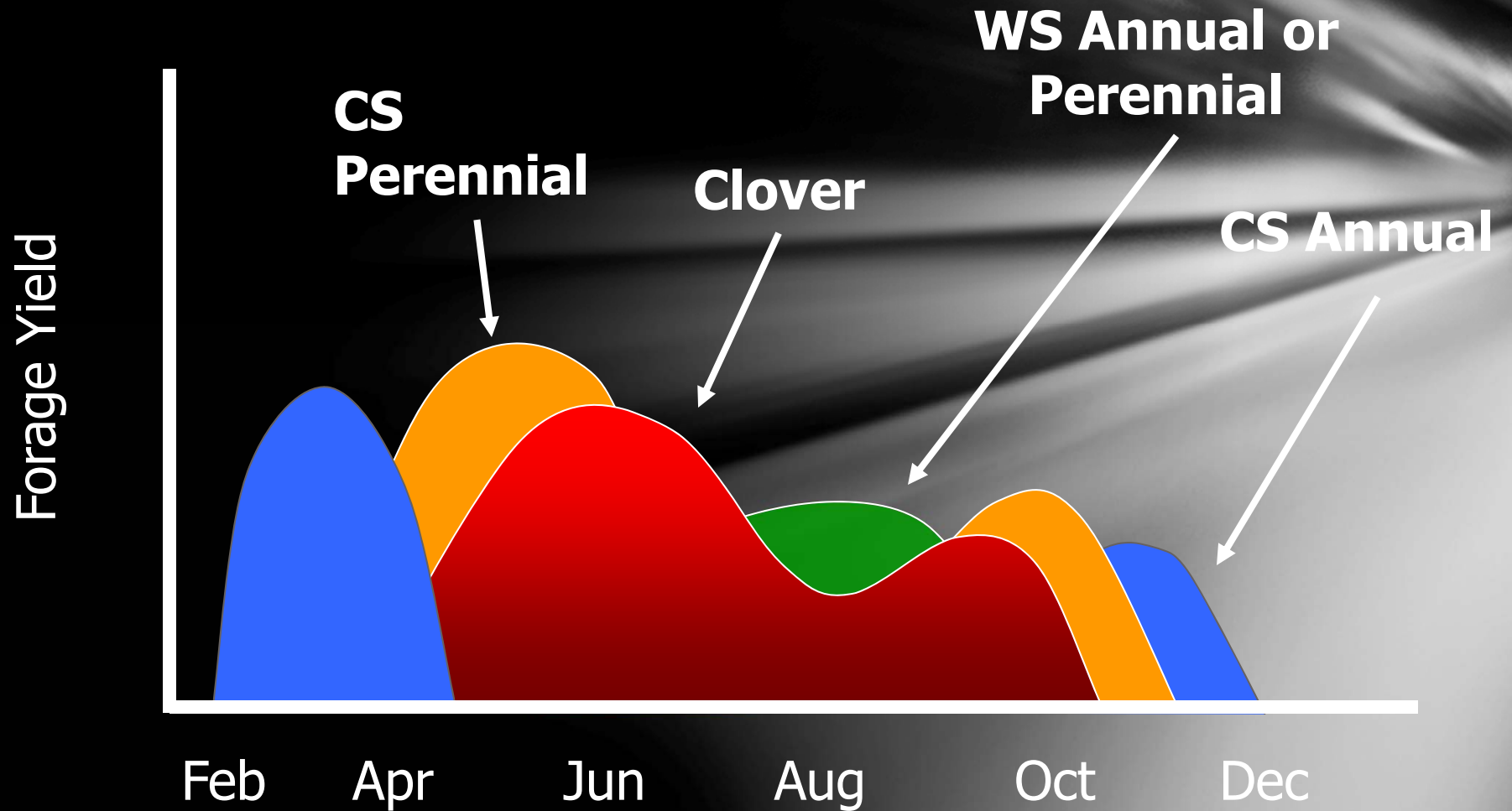
Cool Season Grass with Alfalfa



Warm Season Grasses

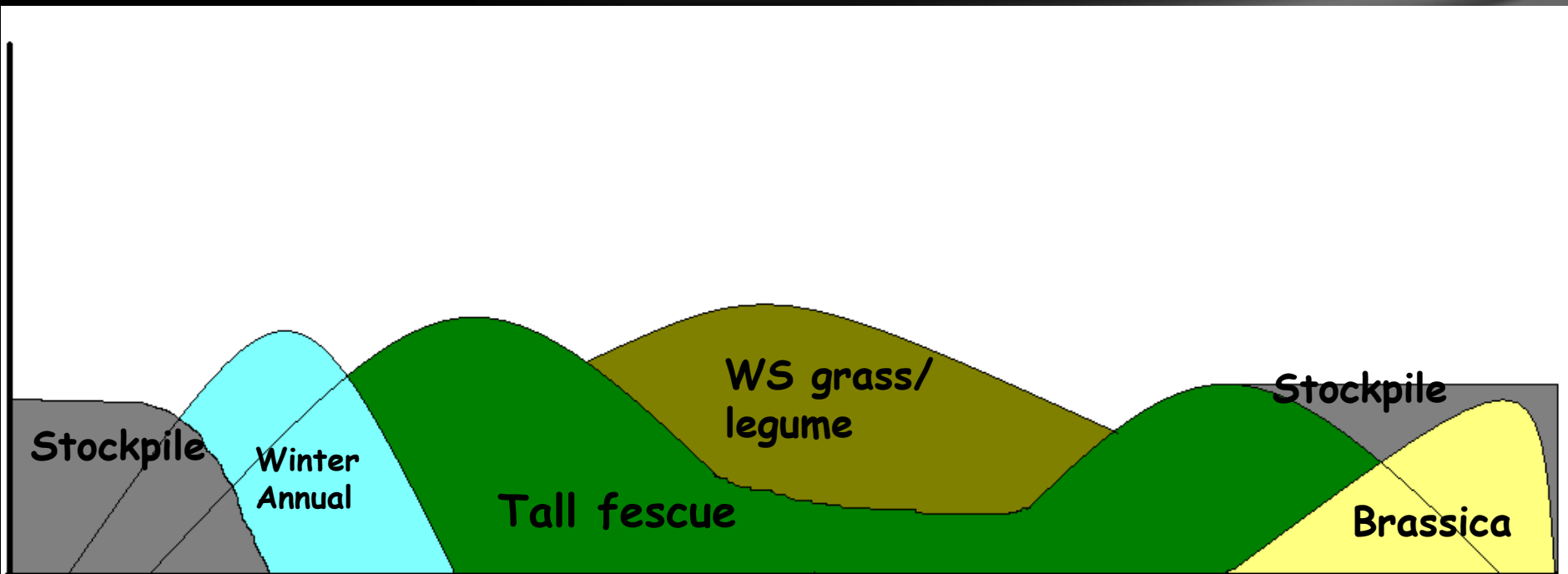


A Balanced Forage System



365 Days of Grazing?

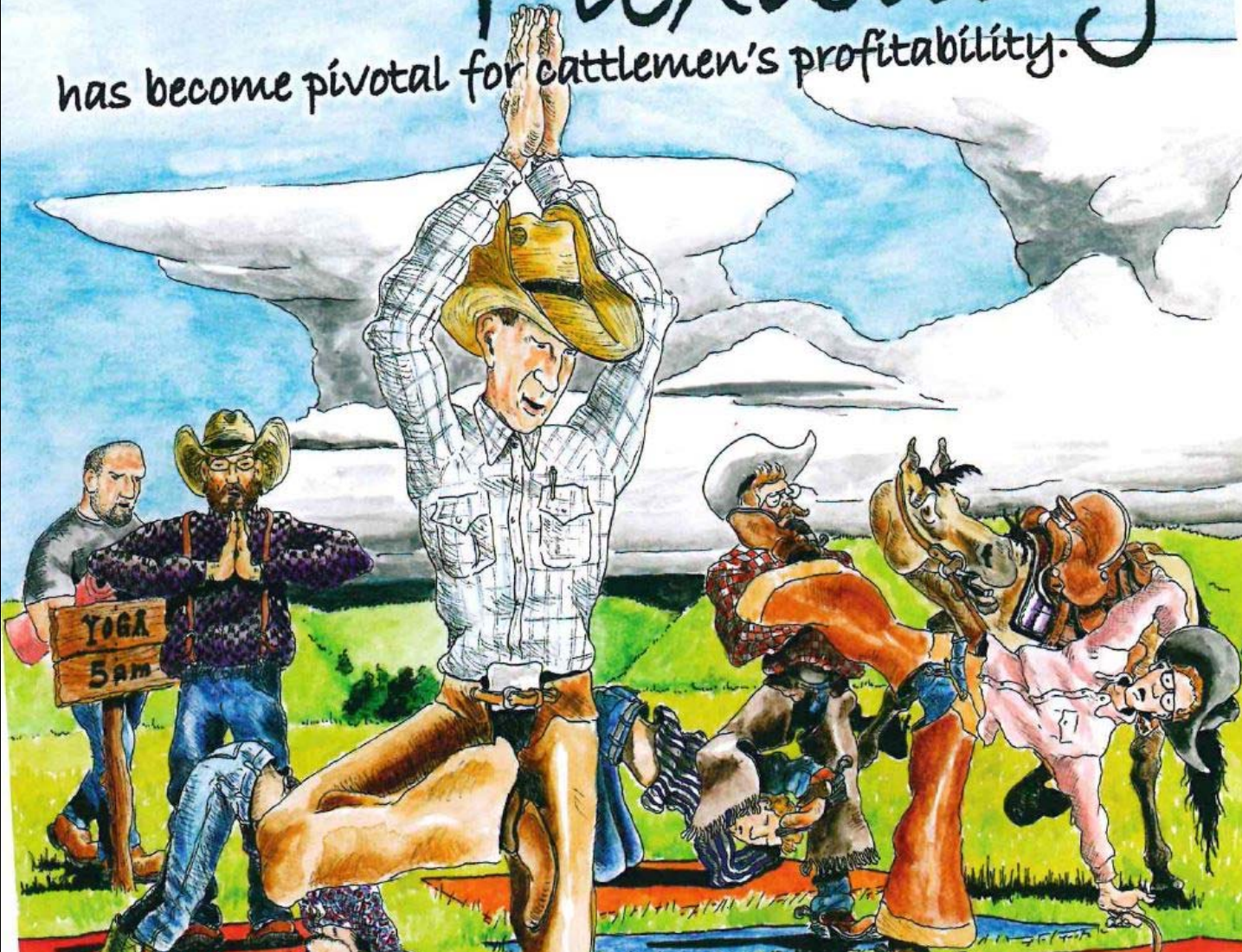
Adding components to a system
increases level of management



Remember:

Flexibility

has become pivotal for cattlemen's profitability.



QUESTIONS?



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