

# Interseeding Legumes to Improve Pastures and Profits

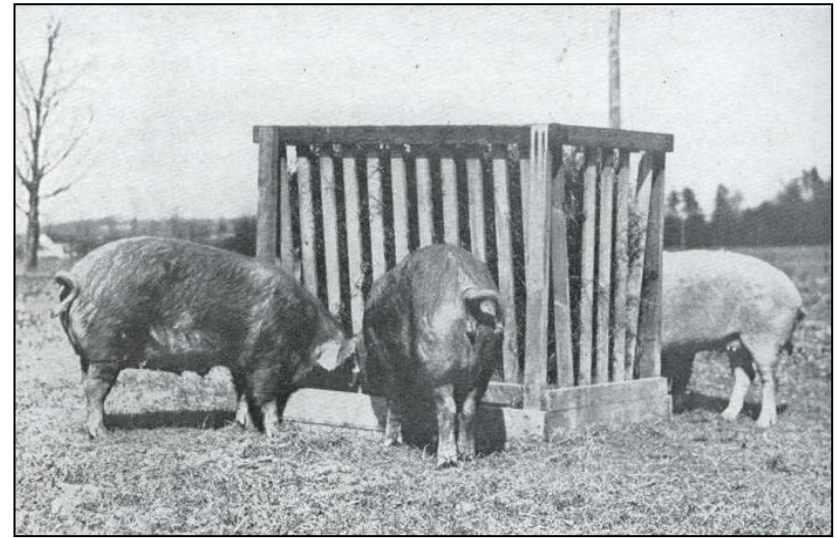
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## GOOD PASTURE PROVIDES VITAMINS, PROTEIN, AND MINERALS

These young pigs and their mothers, which are on good alfalfa pasture, will be amply provided with vitamin A and calcium. The alfalfa forage will also aid in furnishing protein to balance the ration. The sunlight will supply vitamin D.



## SWINE NOT ON PASTURE SHOULD HAVE LEGUME HAY

With the few exceptions pointed out in this chapter, all swine not on pasture should be supplied with well-cured legume hay to protect them against a lack of vitamin A or vitamin D. These sows are provided with good alfalfa hay in the rack. (From J. P. Willman, New York, Cornell, Station.)

Morrison, Feeds and Feeding, 20<sup>th</sup> Ed. Published 1936





## Grass/Legume Pastures

- Why interseed legumes?
- Adaptation & variety selection
- Seedbed preparation
- Inoculants
- Value toward fertilizer budgets
- Management



# Forage Establishment

**Goal: A thick, vigorous stand of forage to maximize yield and utilization**

Proper seeding practices – Favorable seedbed

Favorable environmental conditions – Seedling management



Photo courtesy of Mike Trammell

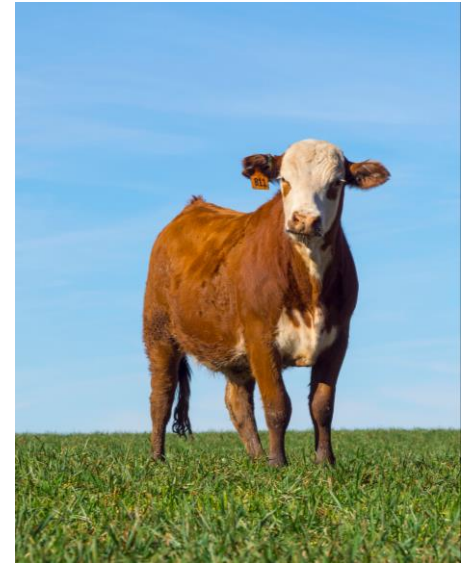


# When Establishing New Forages...

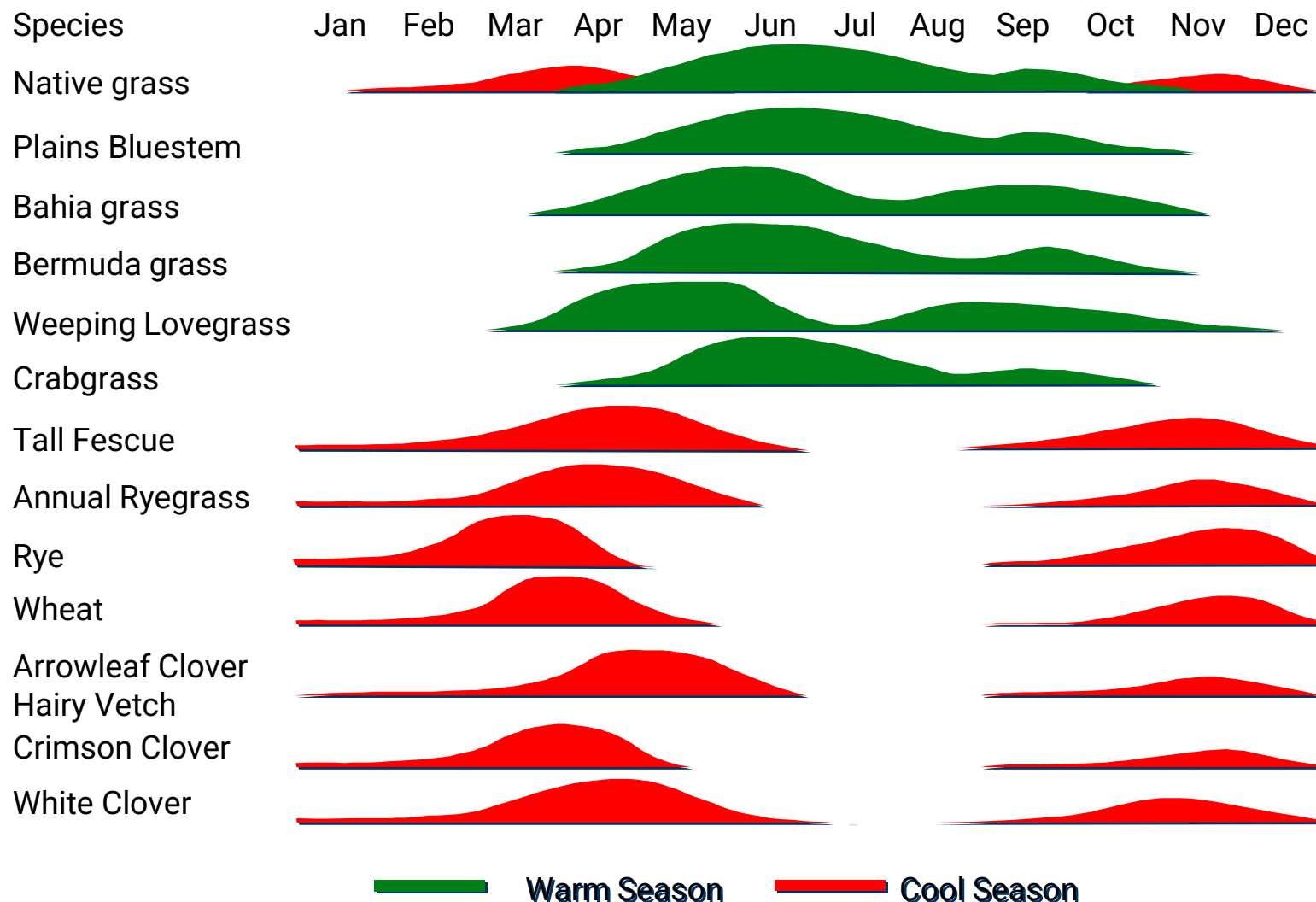


# Why Overseed Pastures with Legumes?

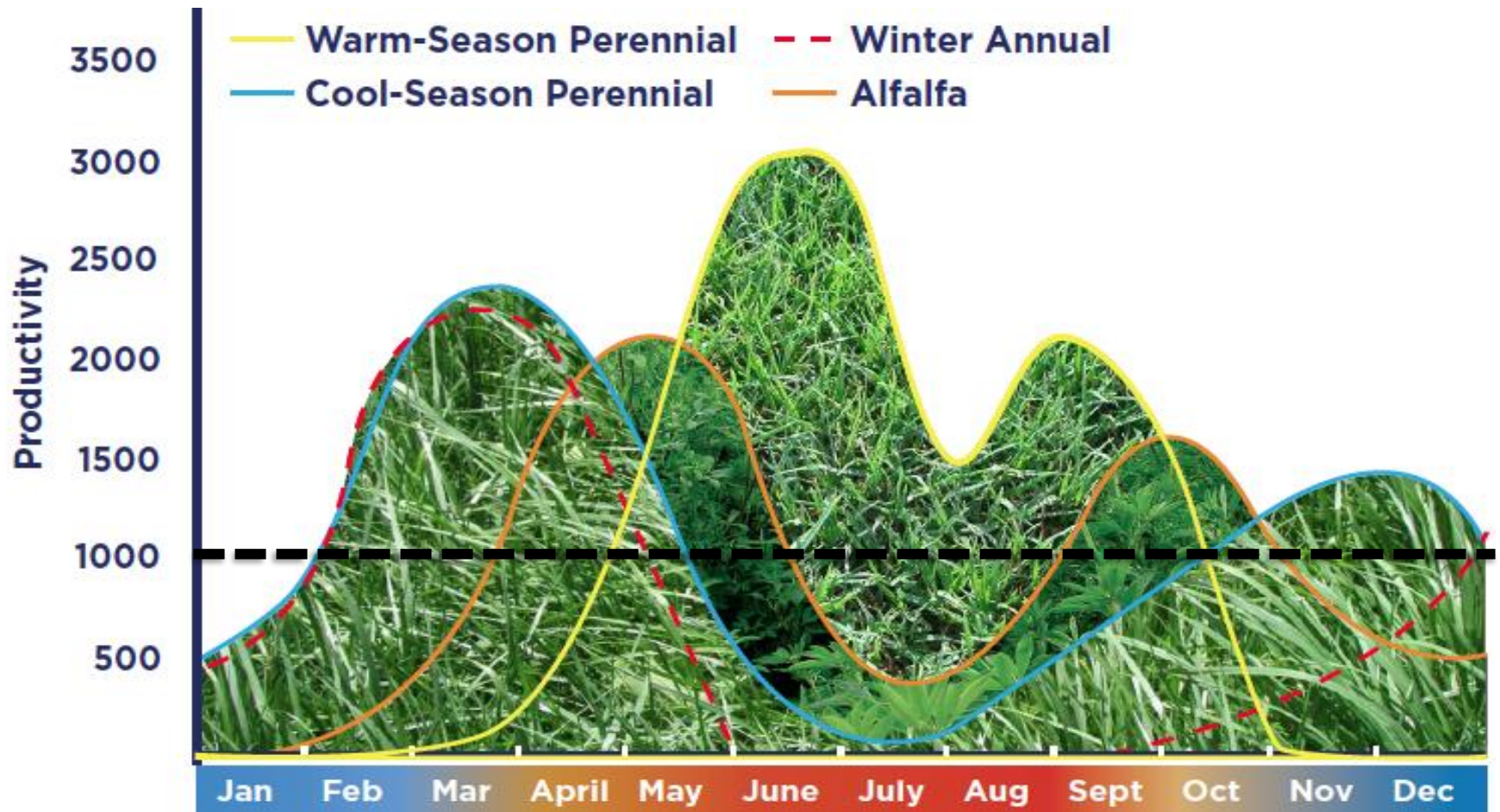
- Extend the grazing season
- Improve quality of forage available
- Nitrogen fixation
- Tool to help mitigate the effects of toxic tall fescue



# Seasonal Growth of Selected Forages in Oklahoma



# Year-Round Grazing – Reduce Hay Costs





# Grazing is Much CHEAPER!

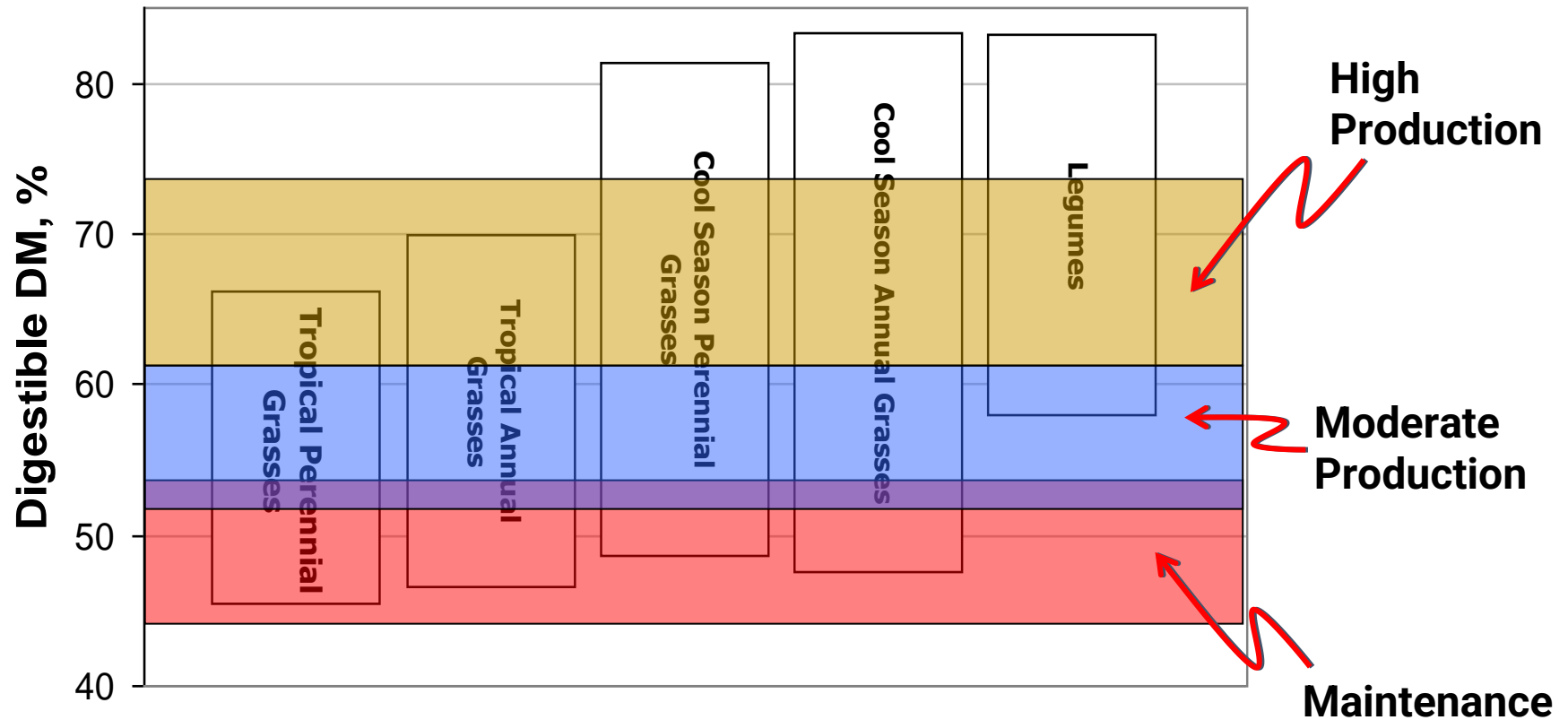
There is **NO** doubt!

The most profitable forage-based livestock systems store very little forage.

- Grazing is generally **ONE THIRD** of the cost of feeding hay.
- The most cost-effective forage harvester has four legs.



# Quality Differences in the Major Forage Species





# Mixtures

vs.

# Monocultures

Can extend grazing season

May increase yield

Adds variety to diet

Free N if legume is in the mix

Can adapt to more environments

Easier to manage

Easier to market hay  
(better consistency)



# Considerations

## It can be risky...

- Rainfall is imperative.
- Can decrease productivity of perennial stand if not managed properly
  - Not ideal for native grasses.
- Establishment is critical.





# So, you want to grow some forages...

What's the first step?



Know your soil



NRCS Web Soil Survey

<https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm>

Oklahoma State Soil Resources Lab

<https://agriculture.okstate.edu/departments-programs/plant-soil/soil-testing/index.html>



EXTENSION

# Pre-establishment Planning

**Start 1-2 years in advance and answer these questions:**

1. Are herbicide residues present? (What is the cropping history on the field to be planted?).
2. What species and variety should I plant?
3. What are the pH and nutritional needs of the crop?
4. Do I need to inoculate legume seed with *Rhizobium* and if so, which strain is appropriate?
5. When is the best time of the year to plant the forage species?

## **STEP 1 – SOIL TEST!!**

Soil sampling methods

<https://extension.okstate.edu/fact-sheets/print-publications/pss/how-to-get-a-good-soil-sample-pss-2207.pdf>

- Use a soil probe, if possible, to get uniform amount of soil at each sampling location.
- Sample systematically across field.
- Mix samples in a bucket.
- Put in a bag and take it to your local extension office.

**Apply soil amendments in advance to allow sufficient time for soil to equilibrate.**





# Herbicide Carry-Over



Photo courtesy of Mike Trammell

Current crop a control problem later?  
 Usually, plant monocots following dicots  
 and dicots following monocots  
 Herbicide residues can injure plants and  
 cause reduced seedling vigor.  
 Plants are slow to grow and often  
 weeds take over fields.  
 So, make sure there is no danger of  
 herbicide injury – keep a cropping  
 record (get one if you purchase  
 land)

Active Ingredient	Product(s)	Rotational Restrictions (months after application)			
		Winter Wheat	Rye	Barley	Alfalfa
2,4-D	Several	3	3	3	3
Atrazine	AAtrex, Bicep II, other products	24	24	24	24
Pendimethalin	Prowl, Squadron	4	9	4	12
Metolachlor	Dual II, Bicep II	4.5	4.5	4.5	4
Dicamba	Banvel	1	1	1	6
Flumetsulam	Broadstrike	4.5	4.5	4.5	4
Imazaquin	Scepter, Squadron	3	18	11	18
Clomazone	Command	12	16	16	16
Metribuzin	Lexone, Sencor, Canopy	8	12	8	4
Chlorimuron	Classic, Canopy	3	3	3	12
Dimethenamid	Frontier	4	4	4	12
Imazathapyr	Pursuit	4	4	4	4
Cyanazine	Bladex	6	6	6	6

Generally, what is bad for one grass or legume is bad for others

# Legume Adaptation

Species	Soil Moisture Adaptation	Soil Fertility Adaptation	Drought Tolerance	Periods Of Production	Relative Maturity <sup>1</sup>	Growth Habit	Height Classification
<b>Legumes</b>							
<b>Alfalfa</b>	Well-drained	High to good	Very good	Spring, summer and early fall	Medium-early	Bunch	Tall
<b>Red clover</b>	Well-drained	Good to medium	Fair	Spring, summer and fall	Medium	Bunch	Tall
<b>Birdsfoot trefoil</b>	Droughty to wet	Medium to fair	Good	Spring, summer and early fall	Medium-late to late	Bunch	Medium <sup>3</sup>
<b>White clover, common</b>	Moist	Medium	Poor	Spring and fall	Medium	Spreading by stolons	Short
<b>White clover, Ladino</b>	Moist	Good to medium	Poor	Spring, summer and fall	Medium	Spreading by stolons	Short to medium
<b>Alsike clover</b>	Most to wet	Fair	Poor	Spring, summer and fall	Medium	Bunch	Medium to tall
<b>Cicer Milkvetch</b>	Dry to wet	Poor to fair	Very good	Spring, summer and fall	Medium-late to late	Spreading by rhizomes	Tall

<sup>1</sup> Maturity classification refers to the relative time of heading (grasses) or flowering (legumes) and depends not only on species but also on variety.

<sup>3</sup> Height of BFT depends largely on variety (Empire types are short suited for pasture and Viking types are upright suited for hay or rotational pasture).



# Forage and Variety Selection

What kind of grazing animal?



When do you want forage?



How much time do you have to take care of pasture?



Establishment and maintenance costs



Irrigation needed or even available?

# Forage and Variety Selection – Pitfalls to Avoid



## **Go with forages that have been grown in your area and are adapted**

For new forages – ask questions.

- Who has planted it? What is the learning curve?  
What are potential problems?



## **Avoid “miracle forages” that promise everything**

Marketing hype oversells many forages

Stick with local and regionally adapted forages and varieties.



# The Development of Dual-Purpose ALFAGRAZE

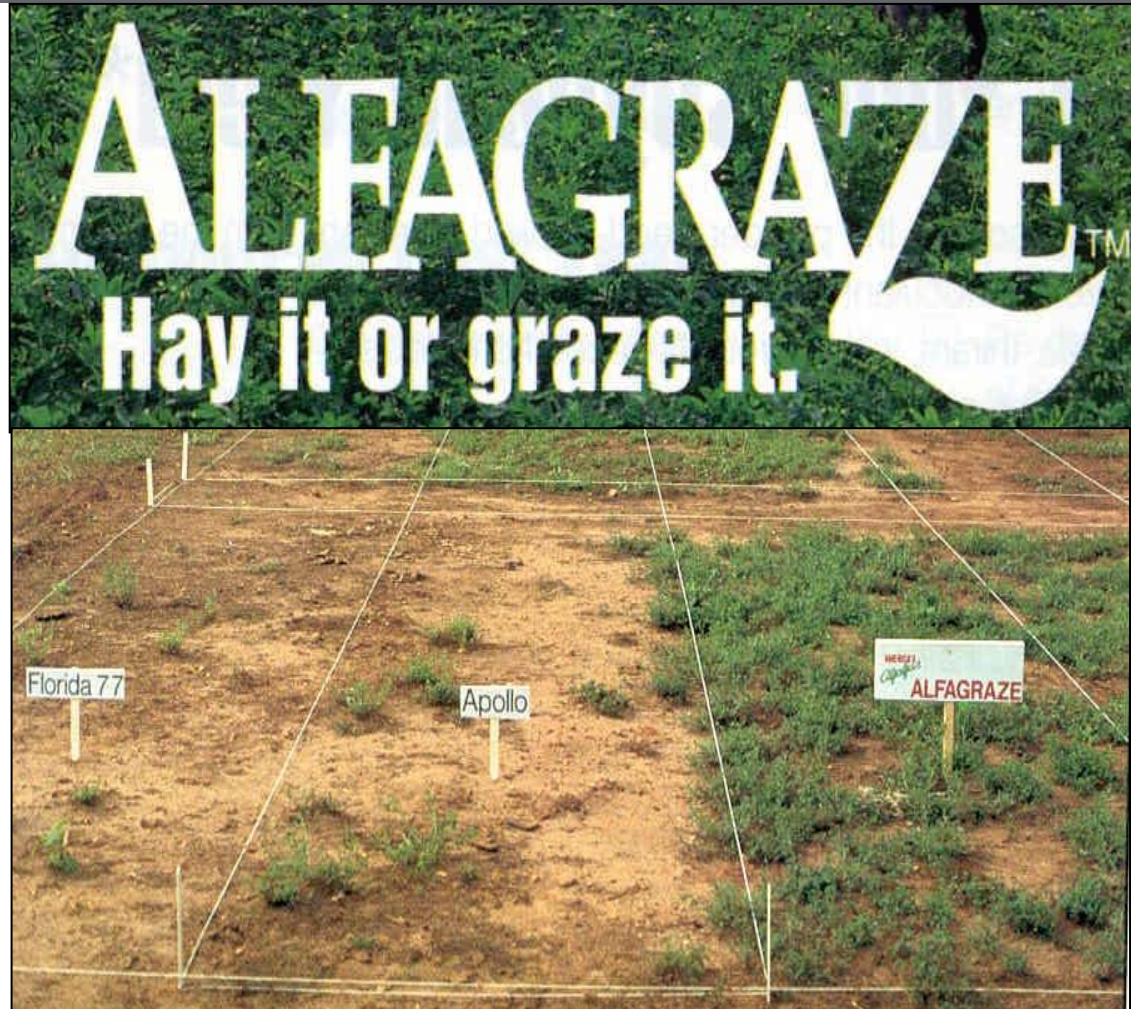
Joe Bouton & Ray Smith



**GERMPLASM  
GRAZED  
CONTINUOUSLY  
AS SPACED  
PLANTS**

**SURVIVING  
PLANTS  
SELECTED AND  
INTERCROSSED**

**POPULATION  
EVALUATED  
UNDER  
CONTINUOUS  
STOCKING**



"Sometimes you do not need statistics, when results are this obvious." –  
Carl Hoveland

# Forage and Variety Selection – Pitfalls to Avoid

**Excessive seed costs**

**Cheap seed of a variety**

Most likely older seed,  
lower purity, lower quality,  
lower germination

**In seed cost, “you get  
what you pay for”**

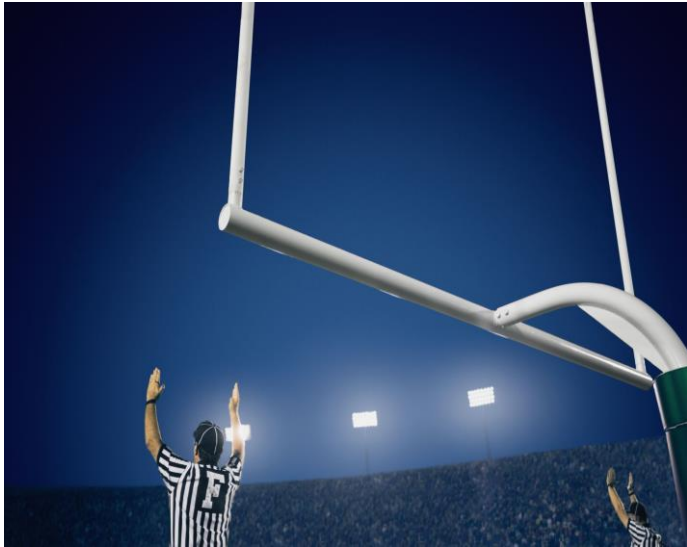
You only want to have to  
establish your selected  
forage once, in the first try



# Use Certified Seed



# Forage and Variety Selection



**The Bottom Line**

**What is your  
goal?**



# Principles for Composing Mixtures

## Mixture Principles

- Keep the mixtures simple.
- Similar maturity dates.
- Similar palatability.
- Similar growth habits.

Crimson clover, orchardgrass, medic



# Compatibility of Legumes and Grasses for Forage Production

Legume	Bahiagrass or bermudagrass	Dallisgrass	Tall Fescue or orchardgrass	Small grain and/or annual ryegrass
Alfalfa			X	
Red Clover		X	X	X
White/ladino clover	X	X	X	
Arrowleaf Clover	X		X	X
Berseem Clover	X	X		X
Crimson Clover	X		X	X
Hairy Vetch	X		X	X
Rose Clover	X			X
Subterranean Clover	X		X	X

Source: Ball et al., 2002.



# Mixtures of Legumes and Grasses

Establish together

- Make sure legumes are not planted too deep

If beginning with a monoculture, easier to establish legume into grass than vice versa

- Advantage of beginning with monoculture – better weed control options
- Chemically suppress the grass and/or graze/mow pasture in late summer (Aug./Sept.)
  - Reduces thatch, provides even canopy
  - Maintains open areas for germination and establishment of the legume seed
  - Reduces habitat for disease infestation

May overseed grass into thinning alfalfa stands

In all cases – need good seed-soil contact

# When to Plant Legumes into Established Grass Pastures or Hayfields

## Established Grass Sod

## Planting Time

Tall Fescue

February – early March

Bermudagrass

Late September - October

Bahiagrass

# Prior to Planting

## Pre-plant herbicide:

- Paraquat – preferred
  - non systemic
  - intensively grazed prior to application

**READ THE LABEL!**

**Label - Paraquat Dichloride 43.2 % (4.14 lbs. a.i. per gallon) – 15 gallons of water as carrier**

Crop	Maximum Number of Applications Per Year	Use Pattern	Gramoxone SL 2.0 Rate Per Acre	Minimum Total Spray Per Acre	Grazing or Preharvest Interval (Days)	Directions
<b>PASTURE RESEEDING</b> <i>(continued)</i> For suppression of existing sod and undesirable emerged broad-leaf weeds and grasses prior to or at time of planting grasses or forage legumes	3	Broadcast	1.0-2.0 pt	Ground: 10 gal Air: 5 gal	See specific geographic comments	<b>Bermudagrass or Bahiagrass Sods</b> <b>Precautions</b> <ul style="list-style-type: none"><li>• Apply in late summer or early fall to sod not exceeding 3 inches in height.</li><li>• For control of emerged Little Barley, apply in February or March before the midboot stage of Little Barley.</li></ul> <b>Bermudagrass and Coastal Bermudagrass Pastures</b> <b>Restrictions</b> <ul style="list-style-type: none"><li>• Do not mow for hay until 40 days after treatment.</li></ul> <b>Precautions</b> <ul style="list-style-type: none"><li>• Apply when bermudagrass is dormant.</li><li>• For control of little barley, apply before the mid-boot stage.</li></ul>



# Prior to Planting

## Pre-plant herbicide:

- Glyphosate
  - systemic
  - needs higher amount of green tissue
  - specific recommendation in the label

Label - Glyphosate 41 % (4 lbs. a.i. per gallon)

### Perennial grass suppression

For suppression of bermudagrass, apply 6 to 16 fluid ounces of this product per acre east of the Rocky Mountains and 16 fluid ounces of this product per acre west of the Rocky Mountains. Apply in a total spray volume of 3 to 20 gallons per acre, no sooner than 1 to 2 weeks after full green-up. If the bermudagrass is mowed prior to application, maintain a minimum of 3 inches in height. Sequential applications may be made when regrowth occurs and bermudagrass injury and stand reduction can be tolerated. East of the Rocky Mountains, rates of 6 to 10 fluid ounces per acre should be used in shaded conditions or where a lesser degree of suppression is desired.

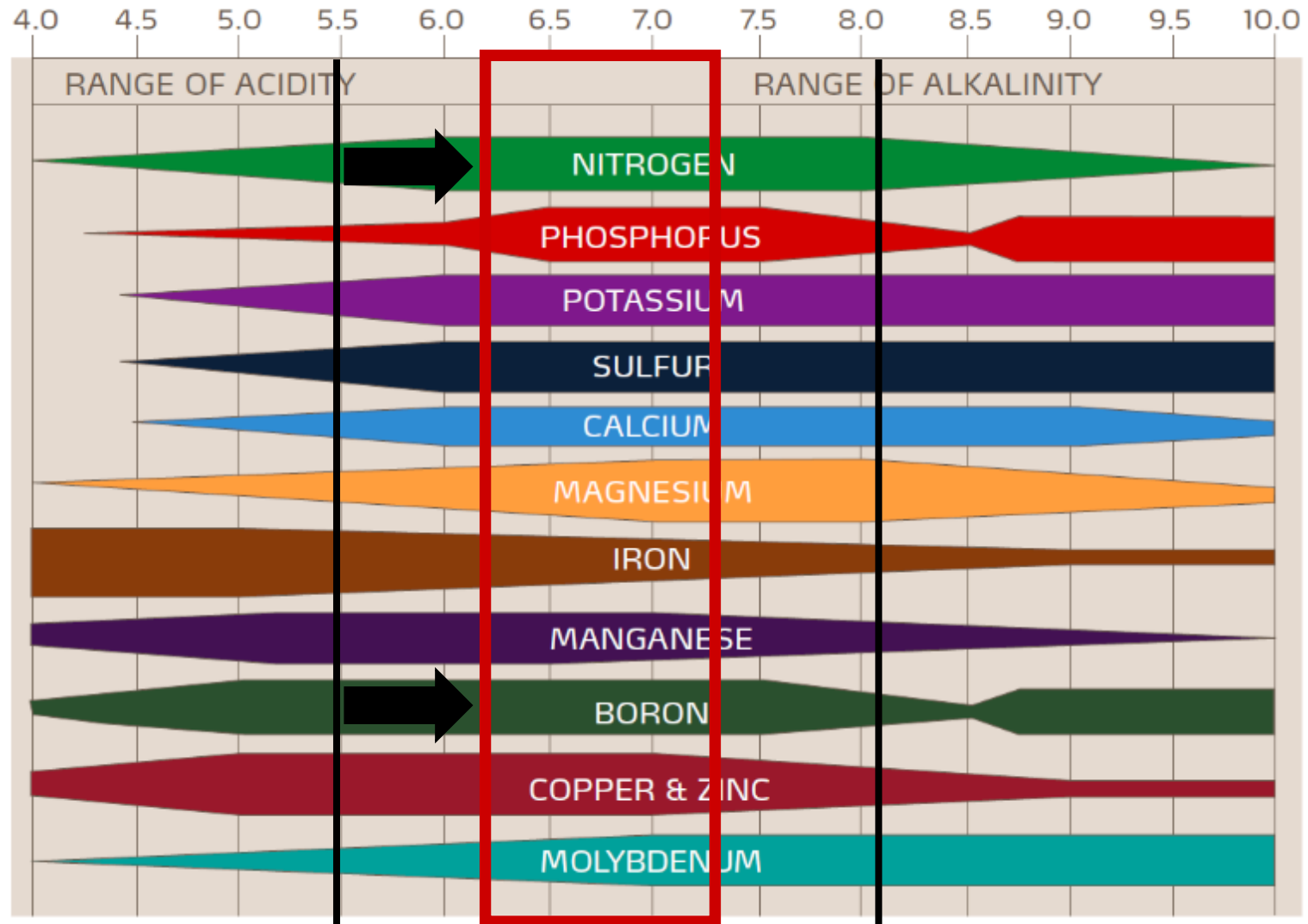


# Soil Fertility

- Legumes grow best at a pH between 6 and 7.
- Don't waste your time planting legumes if your pH is below 5.
- Legumes need P & K to grow properly.
- N fertilization not essential.

# Soil pH and Nutrient Availability

The Influence of Soil pH on Nutrient Availability



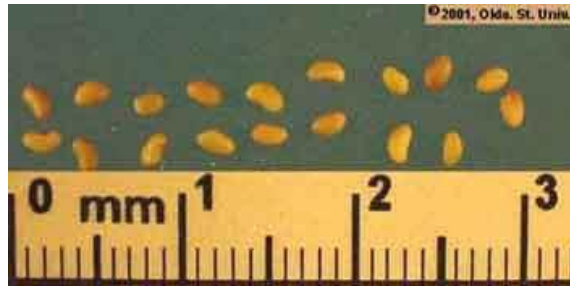


# Legume Seeding and Establishment



- A smooth, firm seedbed is the best
  - Shoe heel sink no more than 3/8" into soil
- Use a packer to firm before seeding if necessary
- Rough, cloddy soils and soils with a lot of plant residue or trash on the surface are not as easy to plant
  - a no-till drill maybe necessary if there is a lot of residue or planting into established sod (fescue, Bermuda or Bahiagrass)

# Controlling Planting Depth – Depth Bands



# Seed Drill Basics

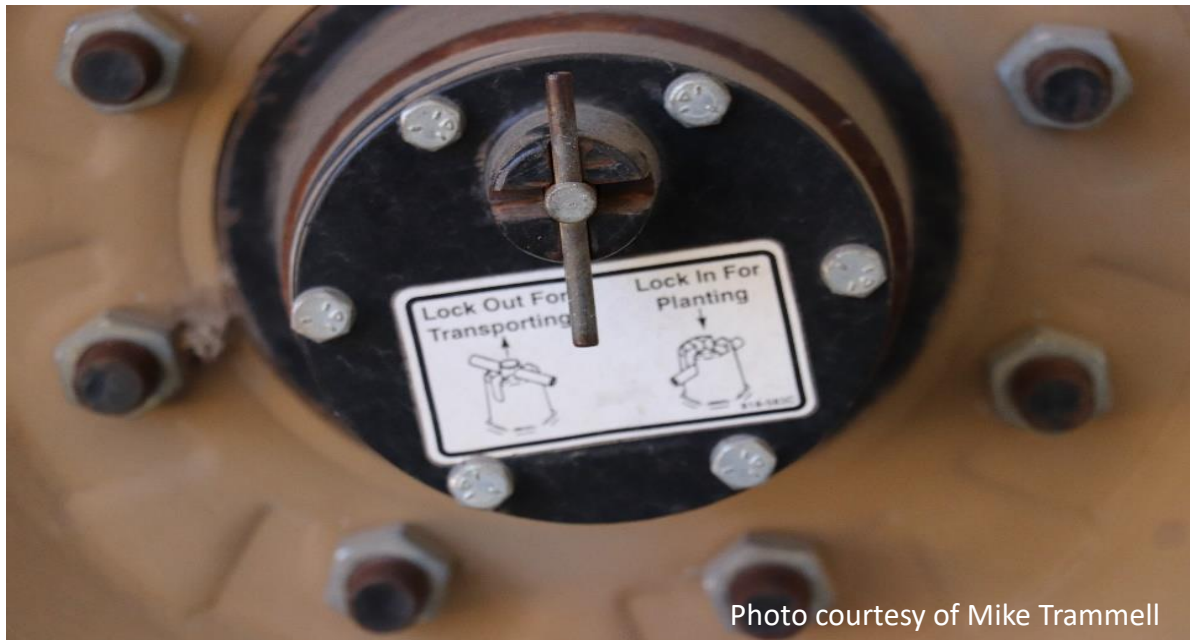


Photo courtesy of Mike Trammell



# Calibrate your seed drill !

## Usually, far more seeds are planted than necessary.

What if the seeding rate is given as **Pure Live Seed**?

### Pure Live Seed (PLS)/acre

- PLS is an indicator of seed quality.
- $PLS = \text{germination} \times \text{purity}$ .



Example: a bag of seed has a purity of 99.48% and the germination rate is 90%.

$$PLS = 99.48 \times 90.0 / 100 = 89.53\%$$

If the recommended seeding rate is 30 lb./ac PLS

The actual amount of seed needed would be  $30 / 89.53 \times 100 = 33.50$  lb./ac

# Seeding Rates of Legumes into Grasses

**Table 1. Recommended seeding rates for legumes commonly planted into pastures and hayfields.**

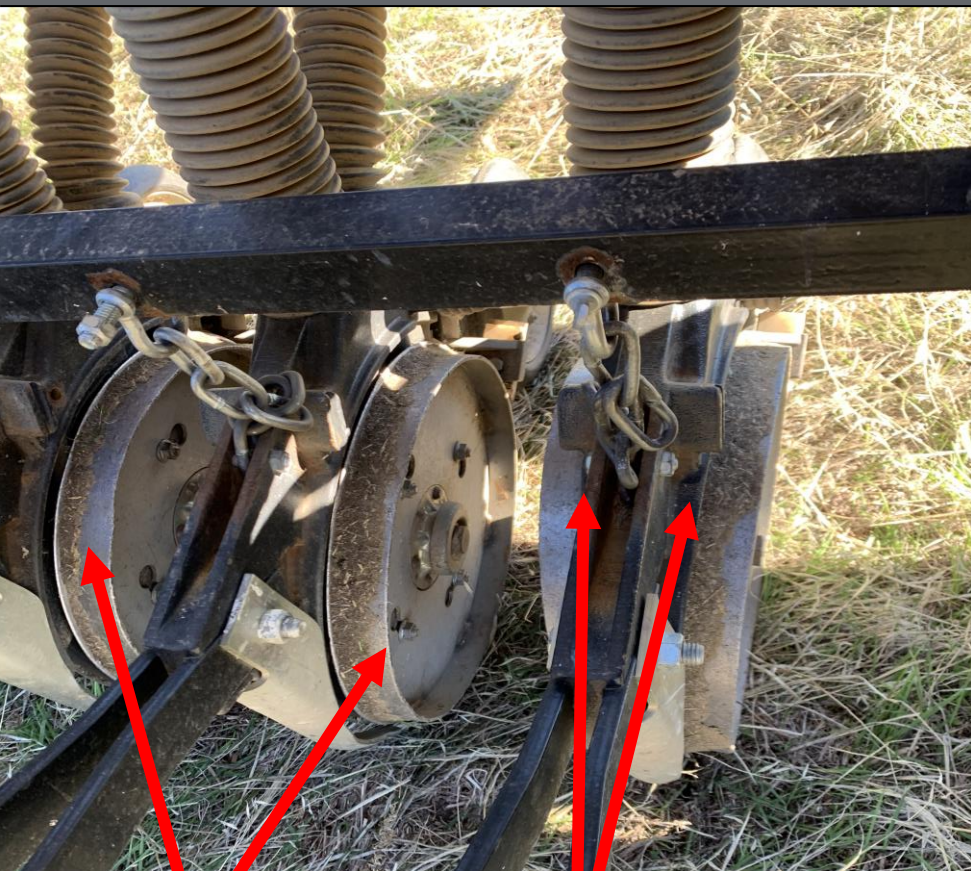
<b>Annual Legumes</b>	<b>Seeding Rate (lbs per acre)</b>
Annual lespedeza ( <i>Kummerowia stipulacea</i> and <i>K. striata</i> )	15-20
Arrowleaf clover ( <i>Trifolium vesiculosum</i> Savi)	8-10
Crimson clover ( <i>Trifolium incarnatum</i> L.)	15-20
Hairy vetch ( <i>Vicia villosa</i> Roth)	15-20
Subterranean clover ( <i>Trifolium subterraneum</i> L.)	12-15
Winter peas ( <i>Pisum sativum</i> L.)	20-30
<b>Perennial Legumes</b>	<b>Seeding Rate (lbs per acre)</b>
Alfalfa ( <i>Medicago sativa</i> L.)	20-25
Red clover ( <i>Trifolium pretense</i> L.)	10-12
White clover ( <i>Trifolium repens</i> L.)	2-3

Rule of Thumb for Mixtures: Divide recommended seeding rate of the legume by the number of species in the mix.

From: Inter-seeding Clover and Legumes into Grass Sod-University of Arkansas Extension, FSA3134

Photo courtesy of Mike Trammell





Depth  
bands

Double disc opener



Press wheels



# No-Till Seeding

Want smooth surface to start....if possible

- Suppress weeds/sod with herbicide.
- Plant directly into dead residue.
- Conserves moisture (better establishment success rate).
- Reduces erosion and crusting.
- Maintains soil structure.
- Reduces fuel and labor costs.



Drill heavy enough to cut through thatch

Depth bands and press wheels optimal – but don't go too shallow!

**Ensure seed-soil contact**

# Controlling Planting Depth – No-Till Drill



# Seeding Depth of Forage Seeds

**Forage seeds are usually small and have limited food reserves, so they are not planted as deep as a grain crop seed.**

- Most forage seedlings are not able to reach the surface if they are planted more than 1" deep.
- Optimum seeding depths are 0.25" to 0.5" on clay and loam soils and 0.5" to 1" on sandy soils.
- A firm seedbed aids in proper seed placement because seeding equipment runs at a more uniform depth.

Established alfalfa plant numbers on three types of soil at four depths of seed placement.

Soil	Depth (inches)			
	0.5	1	1.5	2
Number of plant produced from 100 seed				
Sand	71	73	55	40
Clay	59	55	32	16
Loam	52	48	28	13

Source: Sund et al. 1966.



# Broadcast Seeding of Legumes



- If the available equipment cannot be adjusted to apply the low rate that is required, the inoculated seed can be mixed with coarse sand or some other inert material that is similar in size and weight to the seed.
- Smaller seeds should not be mixed with larger seeds in the hopper or seed boxes, since the small seeds will settle to the bottom.
- Legume seeds should not be mixed with fertilizer, since the fertilizer may kill the inoculant.

- When planting into an existing sod, broadcasted seed should be “scratched-in” to the soil by using a spike-toothed harrow or very light discing. Some producers have also successfully used a pasture aerator.



*Red clover broadcast seeded into a stand of tall fescue*

# Top 5 Reasons Establishments Fail



Photo courtesy of Mike Trammell

- Seed planted too deep.
- Inadequate weed control.
- Planting too late in the season.
- No patience.
- Environmental conditions.



# Legumes





# How much nitrogen can legumes fix?



N-fixation varies due to:

- Species of legumes grown
- Soil conditions
- Water availability
- Seasonal growing condition

Can vary from 50 pounds/acre/year to more than 300 pounds/acre/year

# Is Inoculation Important?

- Very!!!!
- Must use the proper strain of *Rhizobium* bacteria for each legume species!
- The bacteria that converts atmospheric N to a form available to the plant.



Photo courtesy of Mike Trammell

# Inoculation of Legume Seeds

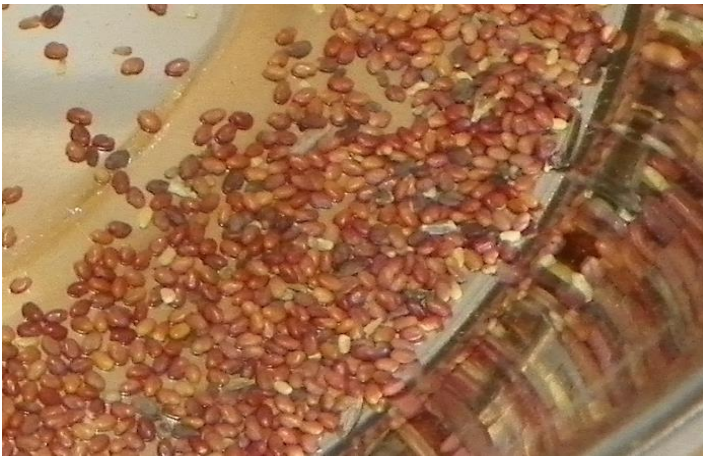
## Inoculation

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The introduction of the appropriate bacteria to the seed prior to planting.

*Rhizobium* bacteria take nitrogen from the atmosphere and convert it into a soluble form useable by the plant.

- Many legume seeds already come pre-inoculated (i.e., coated seed).



Un-coated legume seed

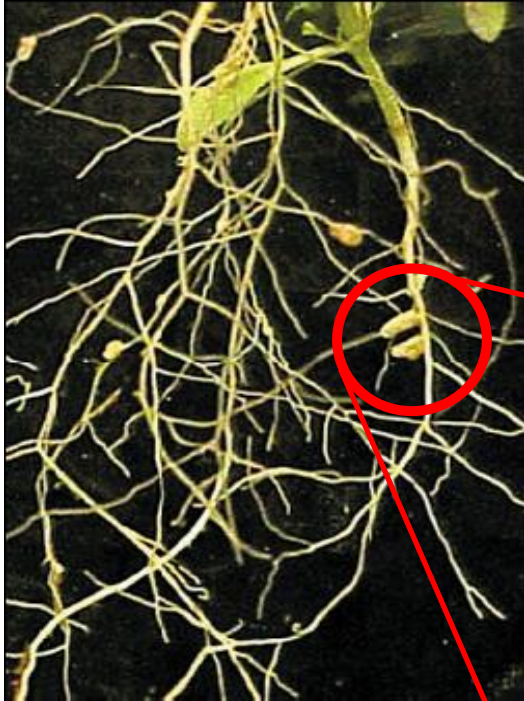


coated legume seed



# Inoculate Your Legume Seeds

**Without proper inoculation, legumes will not establish well**



Due to their symbiotic relationship with Rhizobium bacteria, legumes can convert atmospheric N to plant available forms within the legume roots.



After establishment, legumes do not require N fertilization if properly inoculated

# Inoculation of Legume Seeds

- Inoculants contain live bacteria.
- Check expiration date.
- Store in a cool, dry place and do not mix inoculated seed with fertilizer as both practices can be lethal to bacteria.



# Costs for Nitrogen vs. Interseeding Legumes

- Based on a cost of \$0.92 lb. of Nitrogen (\$850 per ton for urea).
- Cost for applying 50, 100, and 150 lbs. N/acre would be \$46, \$92, and \$138 per acre, respectively.

Costs for interseeding legumes into the grazed pasture are less than applying N fertilizer.

- Red clover seeded at 8 lbs./acre at a seed cost of \$2.50 pound.
- The costs for a custom no-till drill is \$20 acre.
- Total costs are \$40 acre.

N rate (lb./ac)	Difference in Cost/Acre for Interseeding Legumes (\$)
50	-6.00
100	-52.00
150	-98.00



**Table 1.** Species, seed cost, seeding rate and cost, potential nitrogen (N) fixed and value of N, and season of production of various forage legumes.

Species	Seed Cost/ Lb	Seeding Rate/ Acre	Seed Cost/ Acre	Potential N Fixed/ Year (Lbs/Acre)	Value* of N Fixed @\$0.50/ Lb of N	Productive Season
Alfalfa <sup>1</sup>	\$3.50 – \$4.50	20	\$70 – \$90	150 – 200	\$75 – \$100	April – Oct.
White Clover <sup>1</sup>	\$3.00 – \$7.50	2	\$6 – \$15	75 – 150	\$38 – \$75	April – Oct.
Red Clover <sup>1</sup>	\$2.50 – \$4.00	8	\$20 – \$32	75 – 200	\$38 – \$100	April – Oct.
Crimson Clover <sup>2</sup>	\$0.75 – \$1.50	20	\$15 – \$30	50 – 150	\$25 – \$75	March – May
Arrowleaf Clover <sup>2</sup>	\$2.00	10	\$20	50 – 150	\$25 – \$75	April – June
Hairy Vetch <sup>2</sup>	\$2.00	20	\$40	50 – 150	\$25 – \$75	April – May
Annual Lespedeza <sup>3</sup>	\$0.75	20	\$15	50 – 100	\$25 – \$50	June – Sept.

\*Does not include value of forage dry matter produced in addition to fixed N

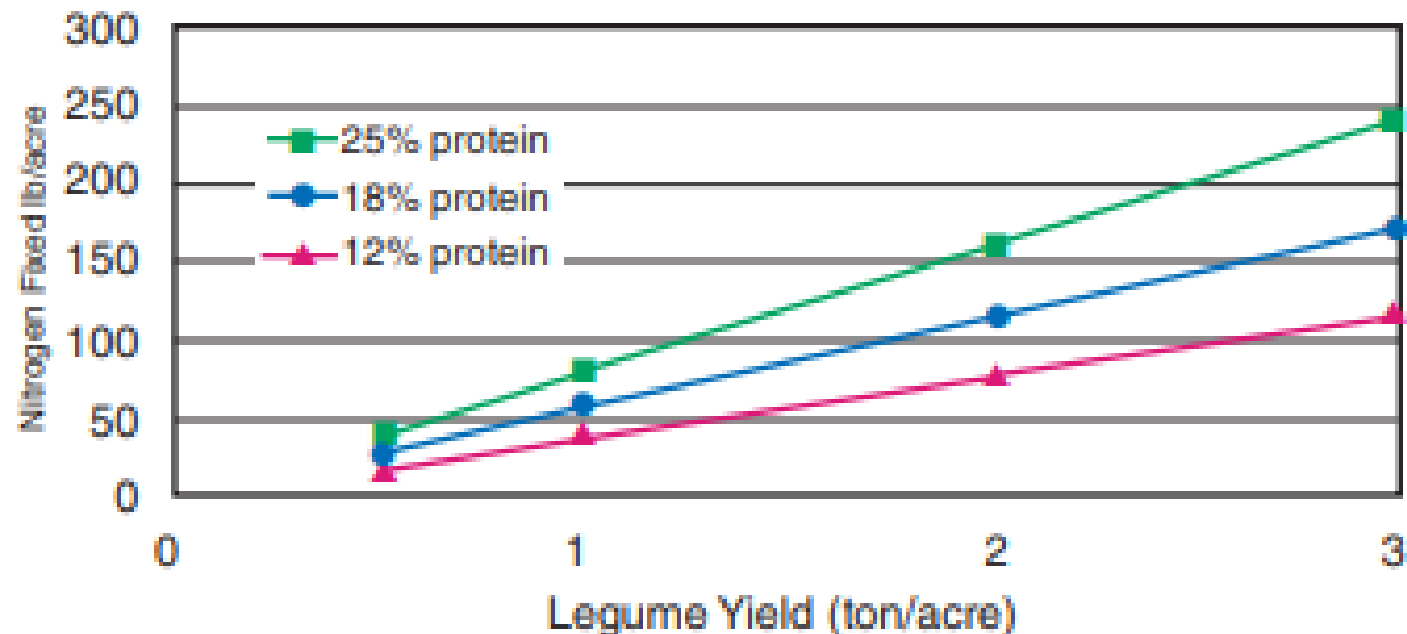
<sup>1</sup>Perennial legume

<sup>2</sup>Winter annual legume

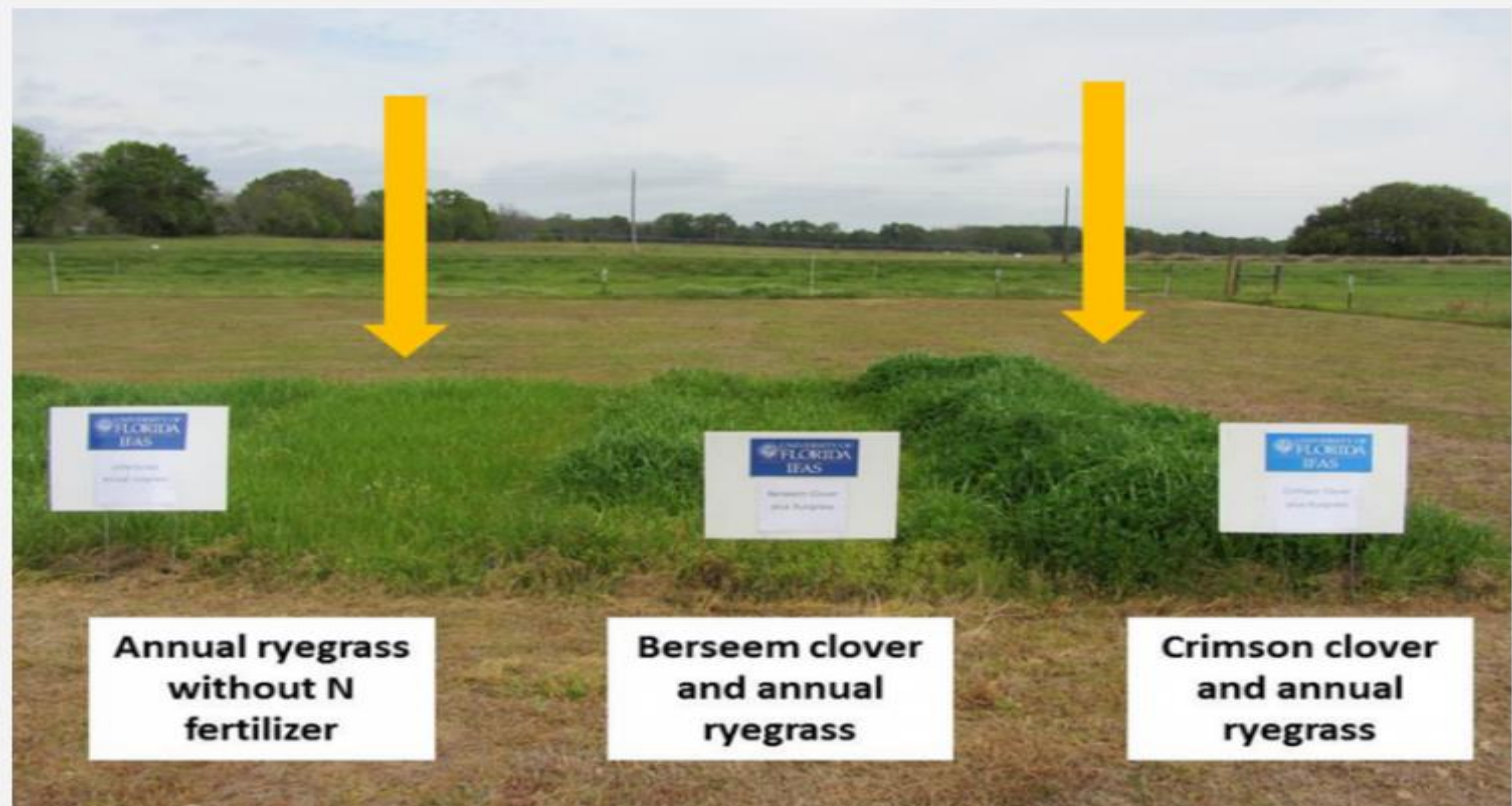
<sup>3</sup>Summer annual legume

Table adapted from University of Arkansas Research and Extension FSA2160 “Value of Nitrogen Fixation from Clovers and other Legumes”.

### Fixed Nitrogen in Relation to Legume Protein and Yield



**Chart 1. Simplified relation between N contribution from legumes, yield, and protein. Increasing yield and/or crude protein increases the amount of N.**



**Table 1. Total dry matter yield (DMY), clover and annual ryegrass DMY in different ryegrass-clover mixtures.**

Treatments	Total DMY lb./ac	Clover DMY lb./ac	Ryegrass DMY lb./ac
Ryegrass-Balansa Clover	1550 b	420 b	1040 b
Ryegrass-Ball Clover	2090 b	540 b	1490 b
Ryegrass-Berseem Clover	2030 b	1530 a	480 b
Ryegrass-Crimson Clover	4090 a	1990 a	1960 a
Unfertilized Annual Ryegrass	870 c	---	850 b
SE	247	201	173
P	< 0.0001	<0.0001	0.0006

Santos et al. (2015).



# Maintenance of Legumes Established into Cool-Season Grass Pastures

## Point #1



Photo courtesy of Mike Trammell

- P & K levels must be maintained at an adequate level if legume production is to continue.
- Annuals will need the opportunity to set seed if production is to be continued.
- Light over seeding of perennials legumes is suggested to continue stand productivity.

# Maintenance of Legumes Established into Cool-Season Grass Pastures

## Point #2

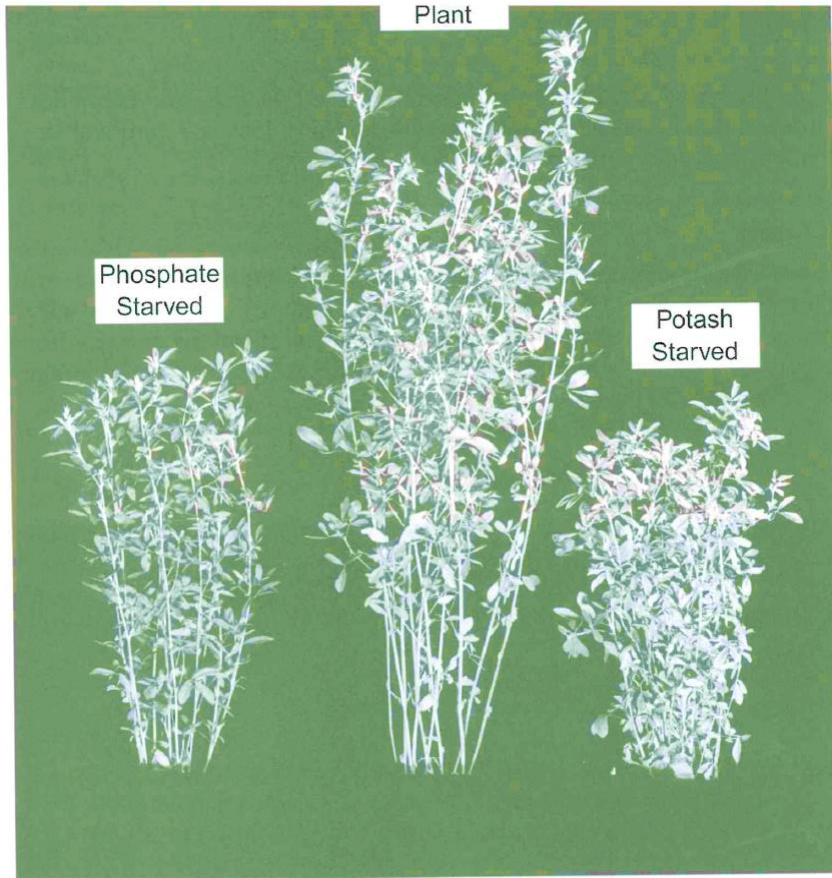


Photo courtesy of Mike Trammell

- Grazing should be deferred until the legumes are well established.
- Grazing and treading of young legumes by livestock can result in loss of significant numbers of seedlings.



# Legumes are not a FREE FERTILIZER option!



**FIG. 12.2.** Effect of phosphorus and potassium on alfalfa topgrowth (Miller 1984). A deficiency of any essential element will restrict forage plant growth even if other elements are present in sufficient quantities to meet plant needs.

- pH, P & K – Apply according to soil test.



**Figure 3.** The alfalfa variety in the middle with the thin stand has limited yield and nitrogen fixation potential compared to the adjacent plots.



# Mixed-Species Fertilization

- Fertilize for the species with the greatest production potential
- If legumes are in the mix, credit their N contribution before applying fertilizer.
- Soil Test



And save yourself some money

# Bloat Prevention

- Grass/legume mixes
- Do not graze when forage is immature
- Turn animals out in afternoon, not morning
- Use mineral blocks with anti-foaming agent
  - Bloat guard (polyoxalene)
  - Ionophores
    - Rumensin (monensin)
    - Bovatec (Lasalocid)
- Bloat safe legumes

**“More money lost to fear of bloat than to bloat itself”**



# Legumes Differ in Bloat Risk

Bloat-causing		Bloat-safe
High-risk	Low-risk	
Alfalfa	Arrowleaf clover	Sainfoin*
Sweetclover	Berseem clover	Birdsfoot trefoil*
Red clover	Persian clover	Cicer milkvetch
White clover	Rose clover	Crownvetch*
Alsike clover	Medics	Lespedeza*

\*Contain condensed tannins that bind protein in rumen and prevent bloat.



# A Timeline for Successful Legume Establishment in Grass Sod

6 – 12 months prior to planting: Start controlling weeds in the field. Soil Test. Select legume species and variety.

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2 – 3 months prior to planting: Select legume species and variety and obtain seed and inoculant.

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1 – 2 weeks prior to planting: Graze or clip field to 2-3" stubble. Calibrate drill or prepare broadcaster.

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Day of Planting: Calibrate! Check planting depth (1/4") after first drill pass in the field.

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After Planting: Graze grass canopy until legumes start to emerge. Remove livestock until legumes reach sufficient size for grazing or haying.

# Summary

## Interseeding Forage Systems

- Extend the grazing season
- Improve forage quality of pasture
- Tool for mitigating toxic tall fescue

## It can be risky....

- Rainfall required
- Proper establishment techniques

## Options

- No-till drill
- Broadcast
- Frost seeding

## Fertilizer

- N fixation
- Soil test for P & K

**While grazing forages is cheaper than feeding hay, is it worth the risk of stand failure?**

# Questions?



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