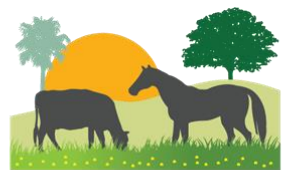




How much nitrogen can legumes provide in grazing systems?

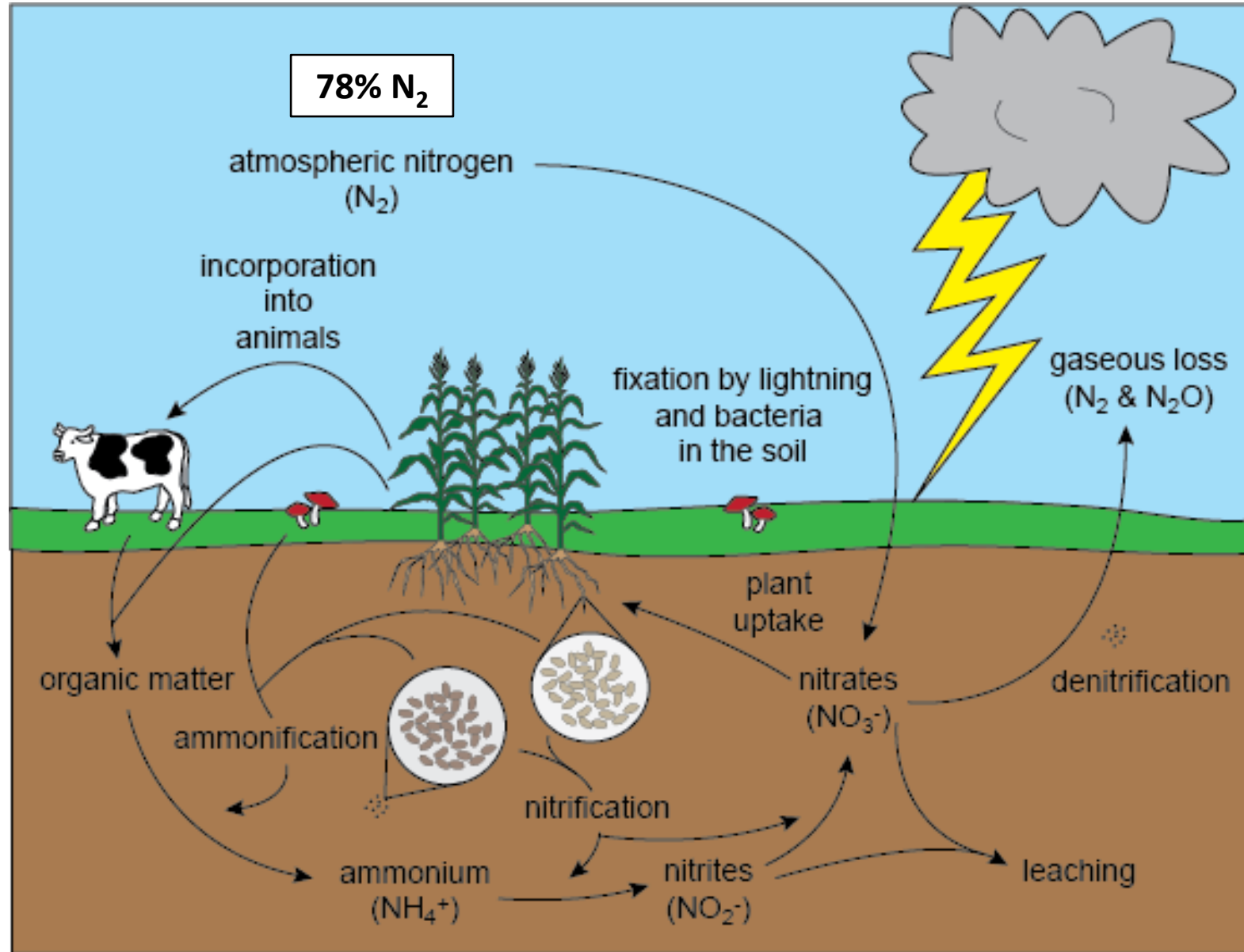
Jose Dubeux

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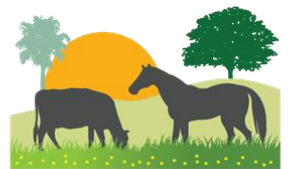
The Nitrogen Cycle



Biological N₂ Fixation



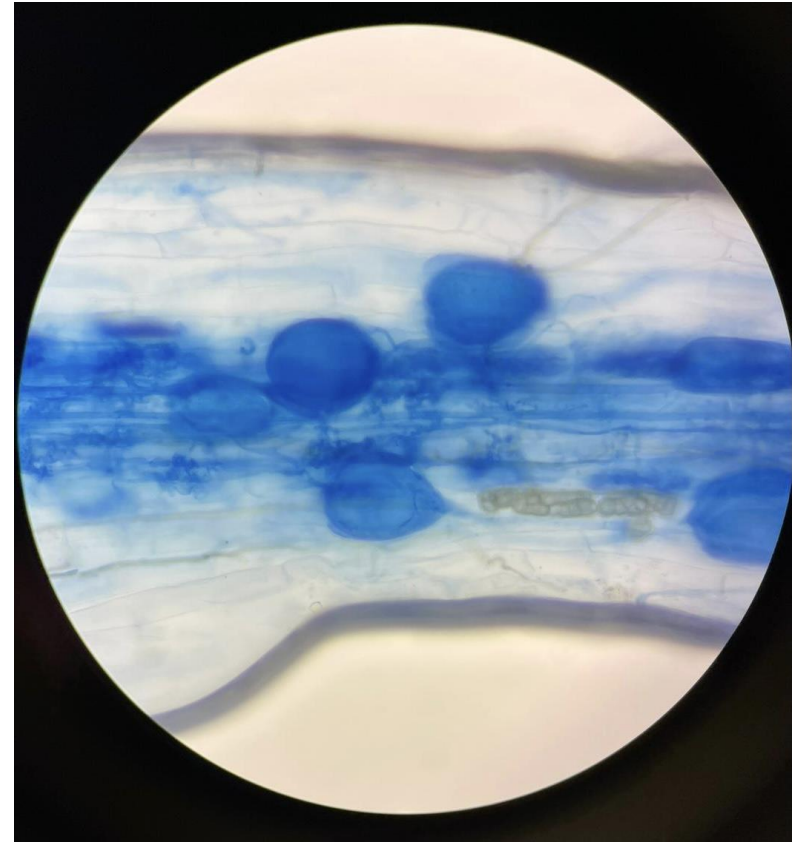
- Forage legumes associate with soil microorganisms and reduce atmospheric N₂
- Proportion of legumes in the botanical composition is key to have significant inputs
- Target at least 30% in the BC



How does N transfer from legume to grass in grazing systems?

- Livestock excreta
- Plant litter
- Root/rhizome turnover
- Root exudation
- Mycorrhizae



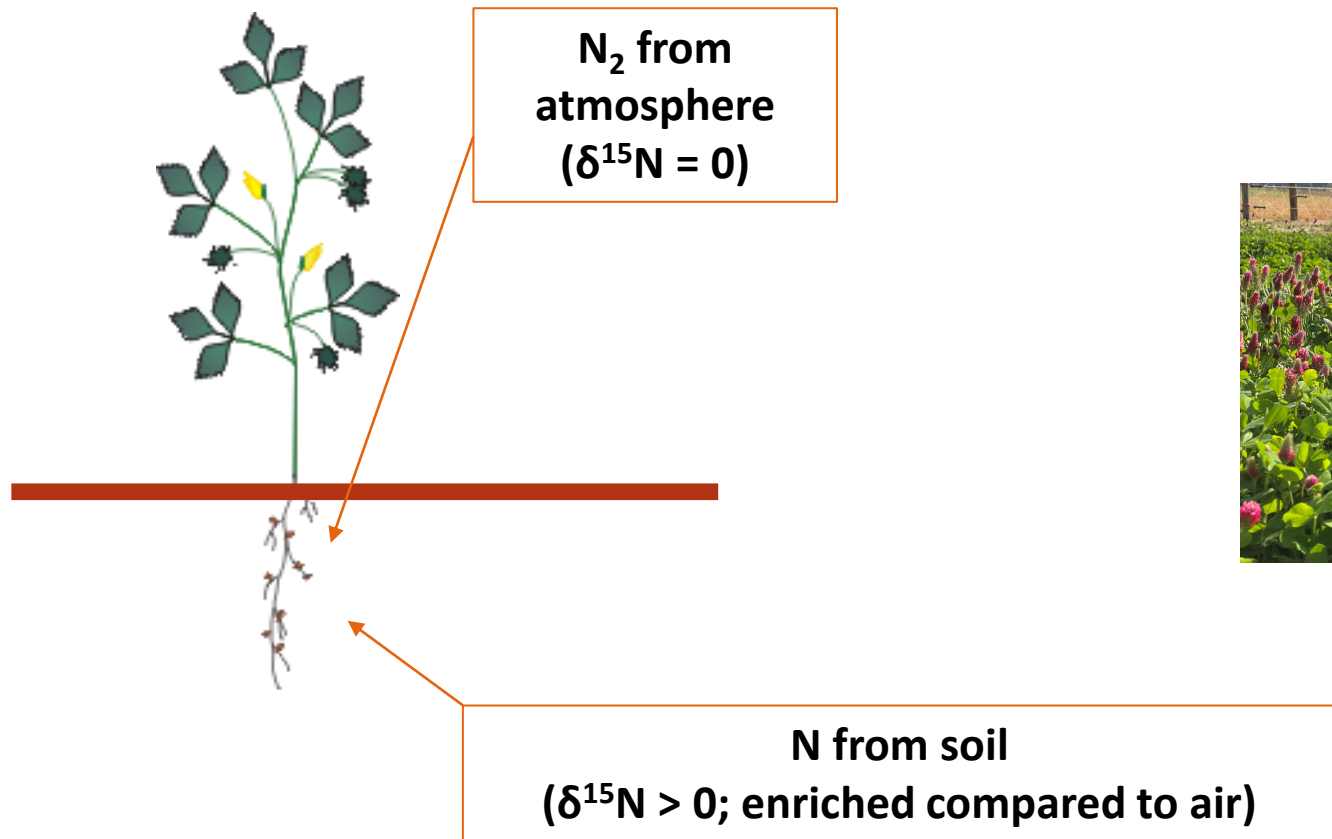


Grass-legume mixtures



**What is the typical BNF
from clovers in SE USA?**

Measuring N₂-fixation using stable isotopes





**Annual ryegrass
without N
fertilizer**



**Berseem clover
and annual
ryegrass**



**Crimson clover
and annual
ryegrass**

Clovers help ryegrass to grow...

Treatments	Total DMY	Clover DMY	Ryegrass DMY
	lb/ac	lb/ac	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

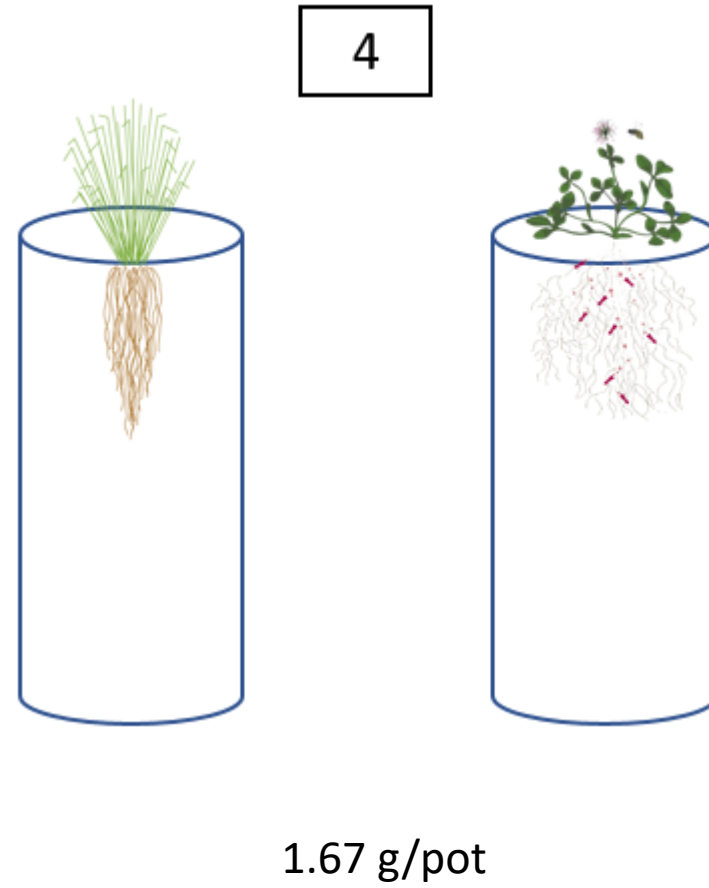
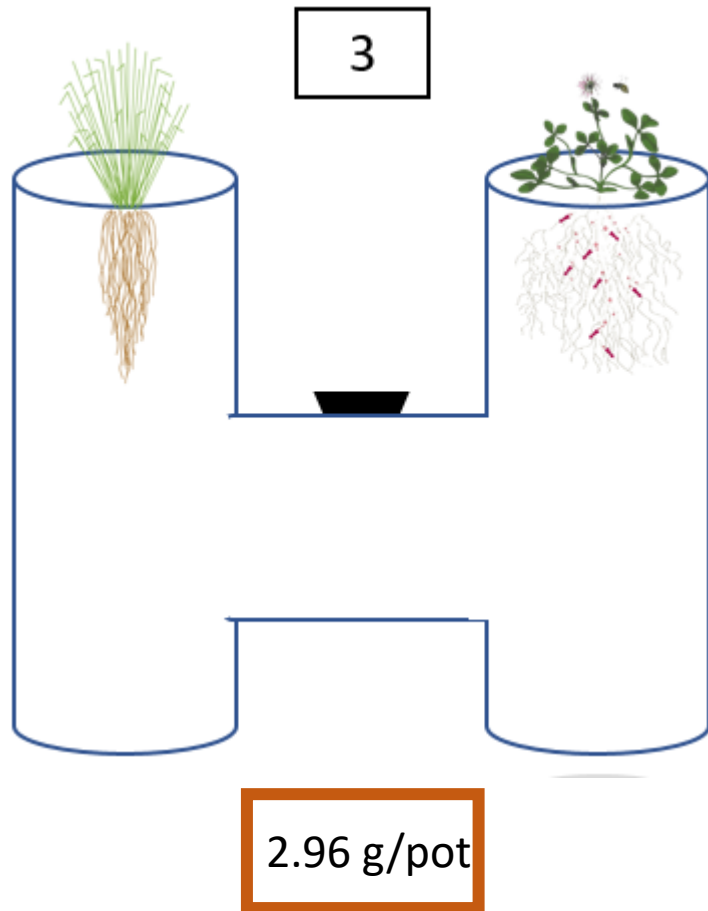
Best clovers fixed almost 50 lb N/acre just from aboveground growth, when mixed with ryegrass

Treatments	Total N Yield	Ndfa	N Fixation
	lb/ac	%	lb/ac
Ryegrass-Balansa Clover	26 b	98 a	12 c
Ryegrass-Ball Clover	36 b	67 c	10 c
Ryegrass-Berseem Clover	44 a	86 b	32 b
Ryegrass-Crimson Clover	78 ab	95 a	46 a
Unfertilized Annual Ryegrass	10 c	---	---
SE	6	2	4
P	< 0.0001	< 0.0001	< 0.0001



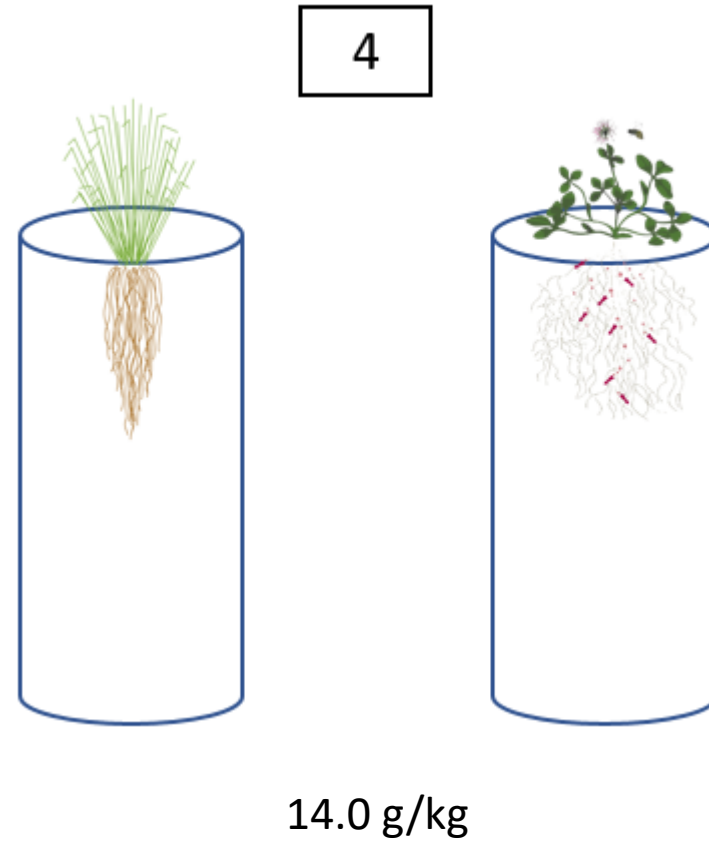
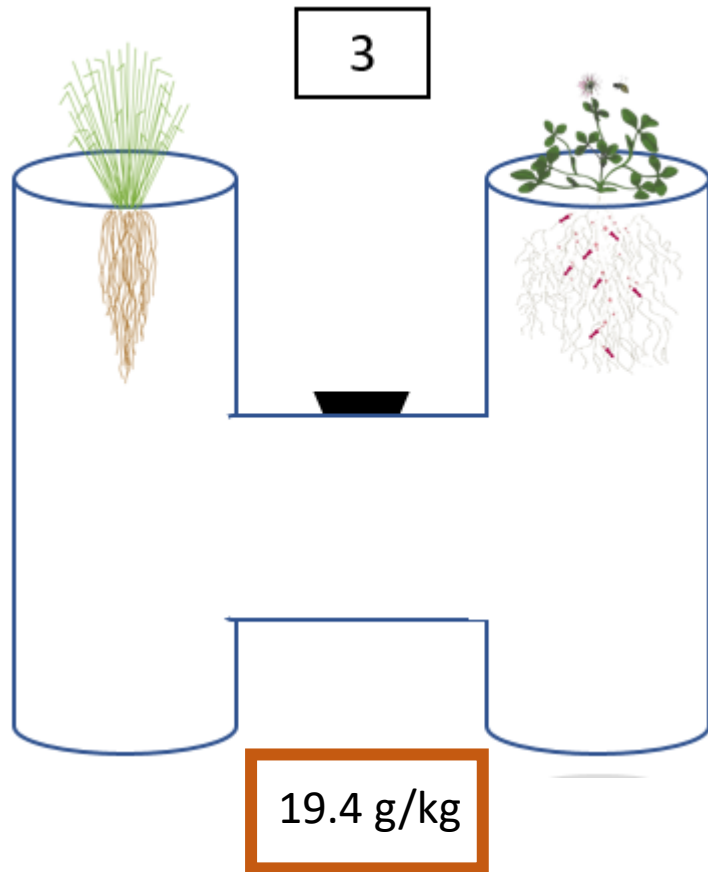
Grass Biomass - Pot type effect

P-value= 0.0423



Grass N g/kg – Pot type effect

P-value = 0.0011



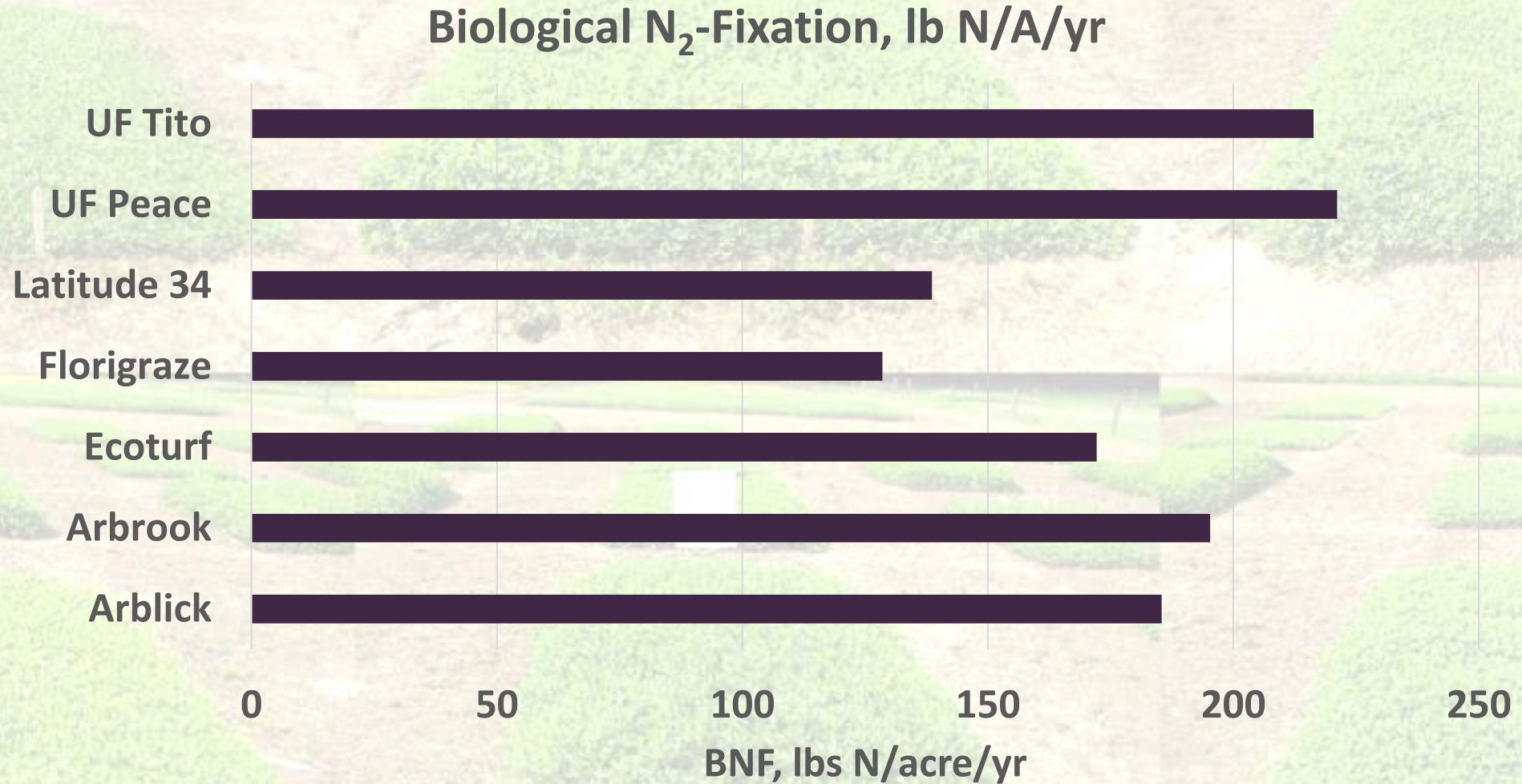
How about summer legumes?

Sunn hemp Cultivar	Herbage accumulation (lb DM/acre)	IVDOM (%)	CP (%)	$\delta^{15}\text{N}$ (‰)	%Ndfa	BNF (lb N/acre)
Crescent Sun	2,864 a	53.1 b	17.6 b	0.88 a	48 a	36 a
Blue Leaf	1,570 b	56.4 a	18.8 a	0.58 a	56 a	22 b
P-value	<0.001	0.017	0.003	0.099	0.084	0.001
SE	383	2.4	1.3	0.15	7	6.2



Adapted from Jaramillo et al. (2020)

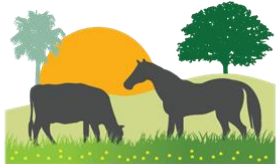
How about perennial peanut?



Average across two seasons (2014 and 2015), with three harvests/season
UF/IFAS – NFREC, Marianna



**How about
roots and
rhizomes?**



Root/Rhizome biomass and N pool in perennial peanut varieties

Cultivar	Root mass, ash-free basis, lb OM/A	Root N, %	Root N, lb N/A
Arblick	17450 ab	1.7 ab	325 abc
Arbrook	15420 ab	1.1 c	186 c
Ecoturf	23990 a	1.9 ab	511 a
Florigraze	9400 b	2.0 a	203 c
Latitude 34	24740 a	1.9 ab	506 ab
UF Peace	19090 ab	1.5 bc	302 bc
UF Tito	14970 ab	1.9 a	315 abc
SE	2475	0.1	50

What is the belowground biomass decay during the year?

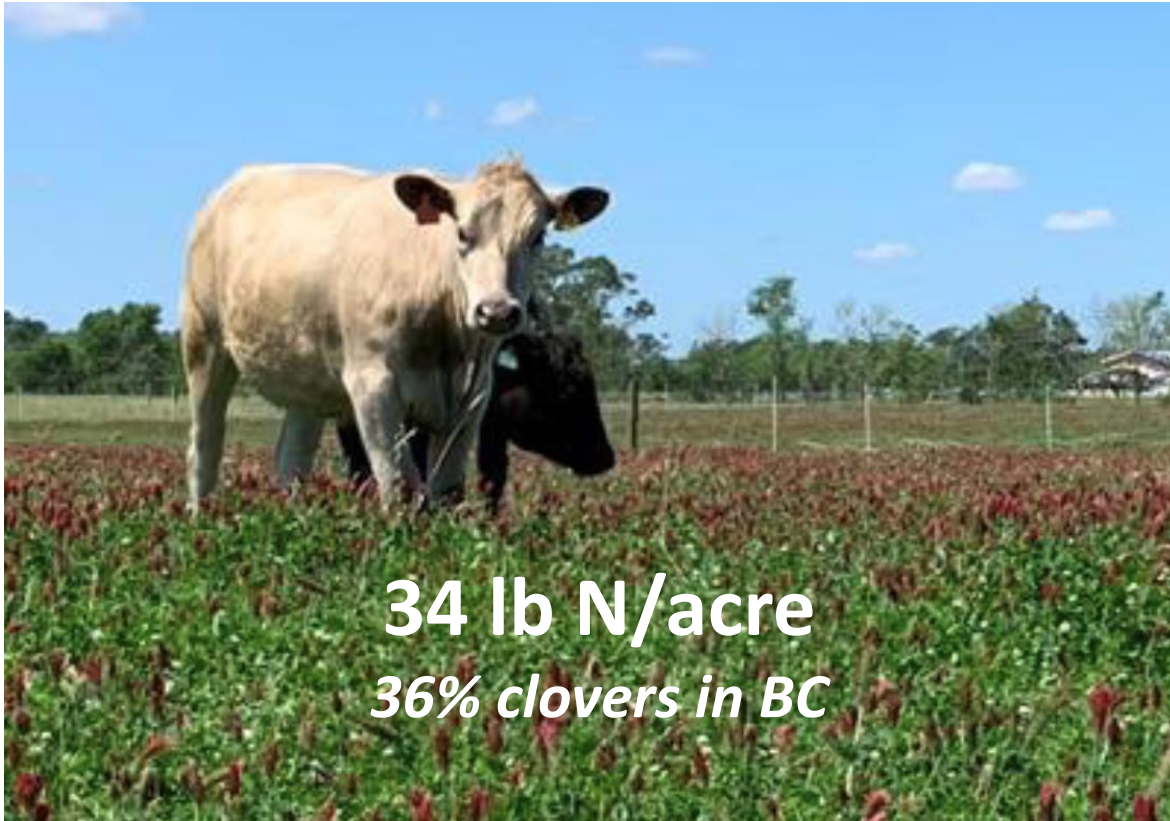


Average of two seasons (2014 and 2015); Marianna, FL, USA

Putting all together: A case study from Marianna, FL

- **Warm season:** Argentine bahiagrass + Ecoturf Rhizoma Peanut
- **Cool-season:** Oat, Rye, Crimson, Red, and Ball clover + 30 lb N/acre





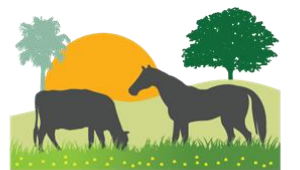
34 lb N/acre
36% clovers in BC



14 lb N/acre
32% RP in BC

Biological N₂ fixation

Total BNF = 48 lb N/acre



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Root/rhizome decay from RP

- Assuming 30% RP in the botanical composition, the average N input from root/rhizome tissues is 20 lb N/acre/yr

Santos et al. (2021; *in preparation*)



Other inputs

- Clover belowground biomass decay (not measured)
- N fertilization (30 lb N/acre/yr)
- SOM mineralization
- Assuming negligible atmospheric deposition



Putting it all together

- 34 lb N/acre (clovers)
- 14 lb N /acre (RP)
- 20 lb N /acre (RP belowground)
- 30 lb N /acre (fertilizer)

Total = 98 lb N/acre + SOM + belowground clover



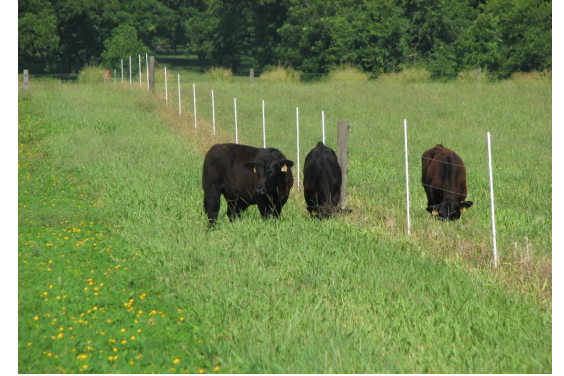
Nutrient cycling: livestock excreta and litter

Item	System			SE	P-value
	Grass+N*	Grass+clover	Grass+CL+RP		
Fecal N, kg ha ⁻¹ yr ⁻¹	35.3 ^a	26.8 ^b	20.8 ^c	4.0	<0.01
Urine N, kg ha ⁻¹ yr ⁻¹	43.5	34.3	41.9	9.4	0.36
Total N excretion, kg ha ⁻¹ yr ⁻¹	78.8 ^x	61.1 ^y	62.7 ^y	12.4	0.05

*Grass+N received 200 lb N/acre/yr; Grass+clover and Grass+CL+RP received 30 lb N/acre/yr

Litter: 42 lb N/acre/yr (Jaramillo et al., 2021)

Animal performance



Cool + Warm Season	Grazing System			SEM	P
	Grass+Clover	Grass+N	Grass+Clover+RP		
ADG, lb hd ⁻¹ d ⁻¹	1.23	1.28	1.52	0.15	.18
GPA, lb acre ⁻¹	503	552	595	92	.46
Stocking rate, steer acre ⁻¹	1.8 A	2.0 A	1.5 B	0.14	.01

Jaramillo et al. (2021; *in review*)

Take Home Messages

- Forage legumes are key to enhance sustainability of forage livestock systems in SE USA
- Forage legumes adds N, enhance diet, and provide other ecosystem services
- Nitrogen cycling is more efficient when using BNF than N from fertilizer



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