Integrated Crop-Livestock Systems: What We Learned and Where We Are Headed

José Dubeux, Erick Santos, and Luana Queiroz

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First things first:

Recognition to Dr. Wright's career

Visionary and team builder

System-oriented research

Lead by example

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Wright's vision:

Integrate crop and livestock systems

Use a perennial grass to build soil health

Crop rotation and integration of grazing livestock

Grazing cover crops

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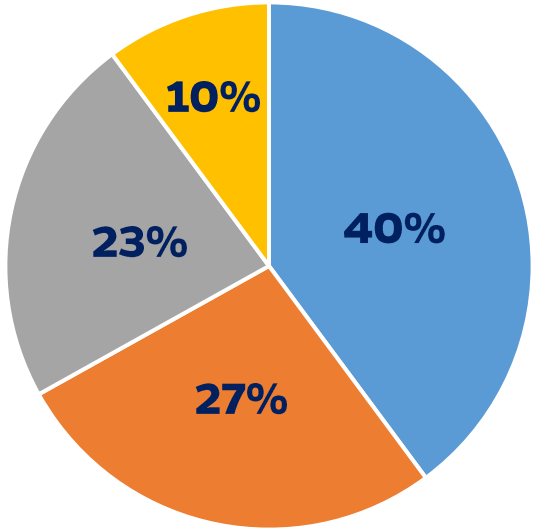
Florida's Major Field Crops

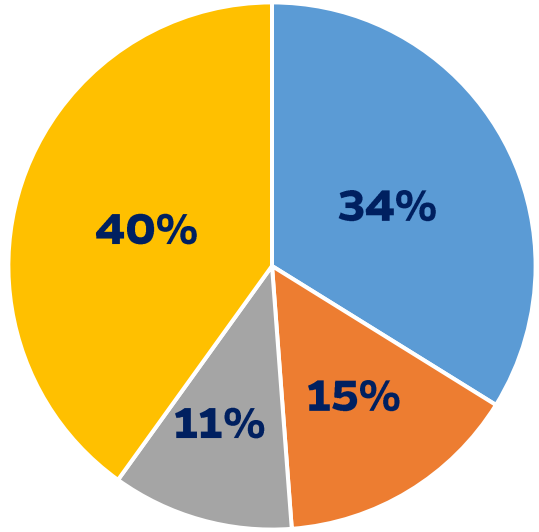
Planted Area



Peanut Cotton Field Corn Sweet Corn

Total planted area ≈ 420,000 acres

Value of Production



Peanut Cotton Field Corn Sweet Corn

Total value of production ≈ $352 million

USDA-NASS, 2019

Agriculture Scenario

Warm season

Row crop irrigation during the warm-season

- 0.25 million ha with harvested cropland
- 0.16 million ha under irrigation
  - **64% of irrigated land**

Cool season

Fallow land during the cool-season

- Soil erosion
- Nutrient leaching

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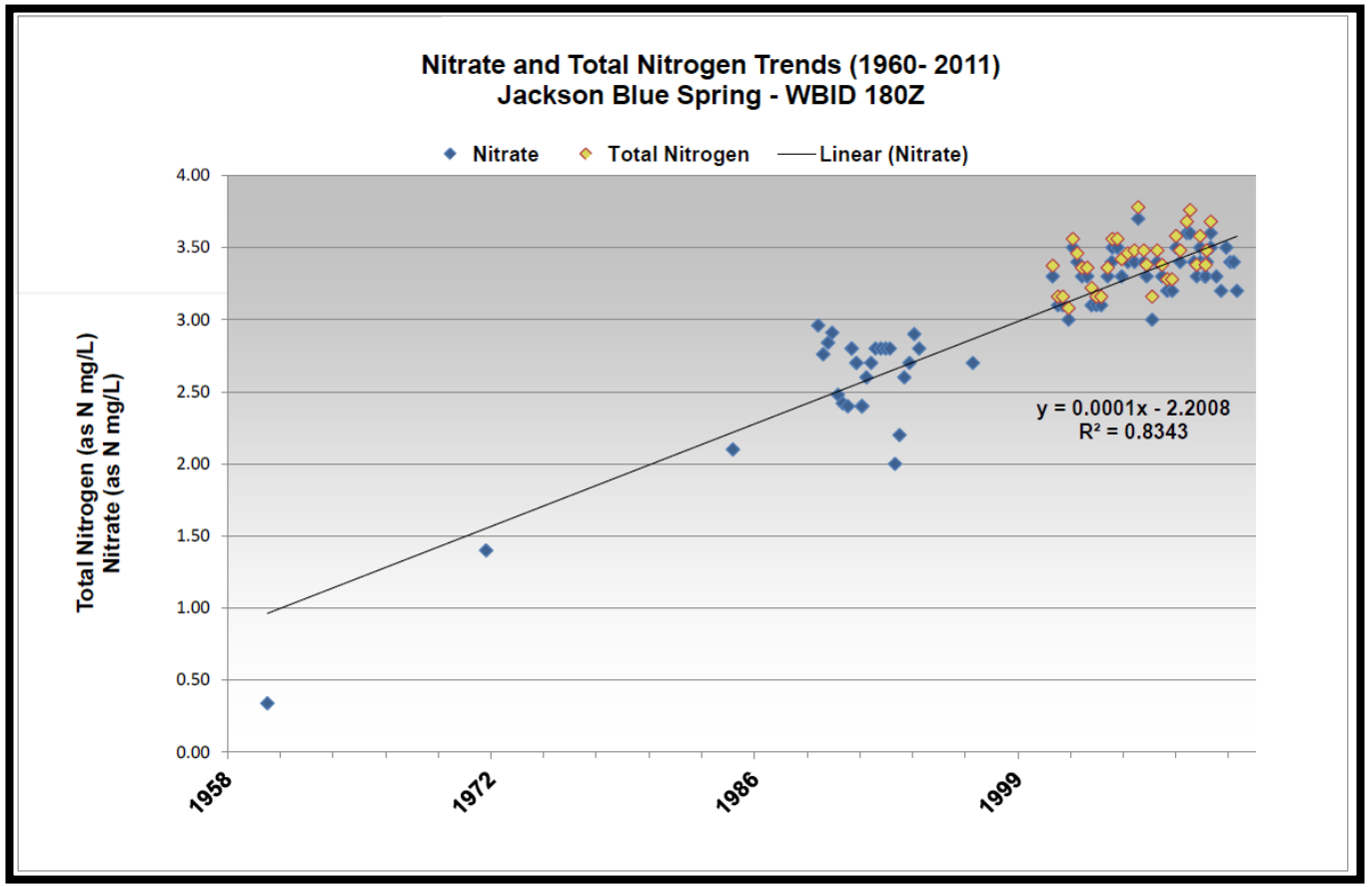

Florida Blue Springs

- First Magnitude Spring
- Most nitrates come from agriculture

Nitrate and total nitrogen concentration in Jackson Blue Spring (Source: BMAP Jackson Blue Spring and Merritts Mill Pond)

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Opportunities to Integrated Systems

Cover Crop

Cover Crop

Stagnant yields
Soil degradation
Pests and diseases

Crookston, 1995
Zentner et al., 2001
Tanaka et al., 2002

Cover Crop

Cover Crop

Cover Crop

Improve soil quality
Increase yield
Withstand pests
Reduce risks
Increase profitability

Cover Crop

Cover Crop

Katsvairo et al., 2006

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Benefits of Cover Crops

- **Decrease Nitrate Leaching**
  - From 6 to 94% (Mikkelsen & Benson, 1991; Kaspar & Singer, 2011)
- **Improve Soil Properties** (Blanco-Canqui et al., 2015)
  - Reduction in erosion and soil compaction
  - Increase in soil organic C
  - Increase nutrient cycling
- **Improve Cotton Yield and Decrease Weeds** (Toler et al., 2019)
  - Cottonseed by 5%
  - Lint yield 6%
  - Reduced weeds by 20%

- **Litter drives SOM and nutrient release dynamics** (Rumpel et al., 2011)
  - Quantity and quality
    - Plant species, N fertilization, and stocking rate

Grazing Cover Crops

Beef cows = 904,000

USDA, 2019

Diet	ADG (kg d^{-1})
Bahiagrass	0.34†
Rye-Ryegrass	0.77‡
Oats-Ryegrass	0.95‡
Triticale-Ryegrass	0.95‡

Cool-season grasses often have greater nutritive value than warm-season grasses

†Jaramillo et al., 2021
‡Dubeux et al., 2016

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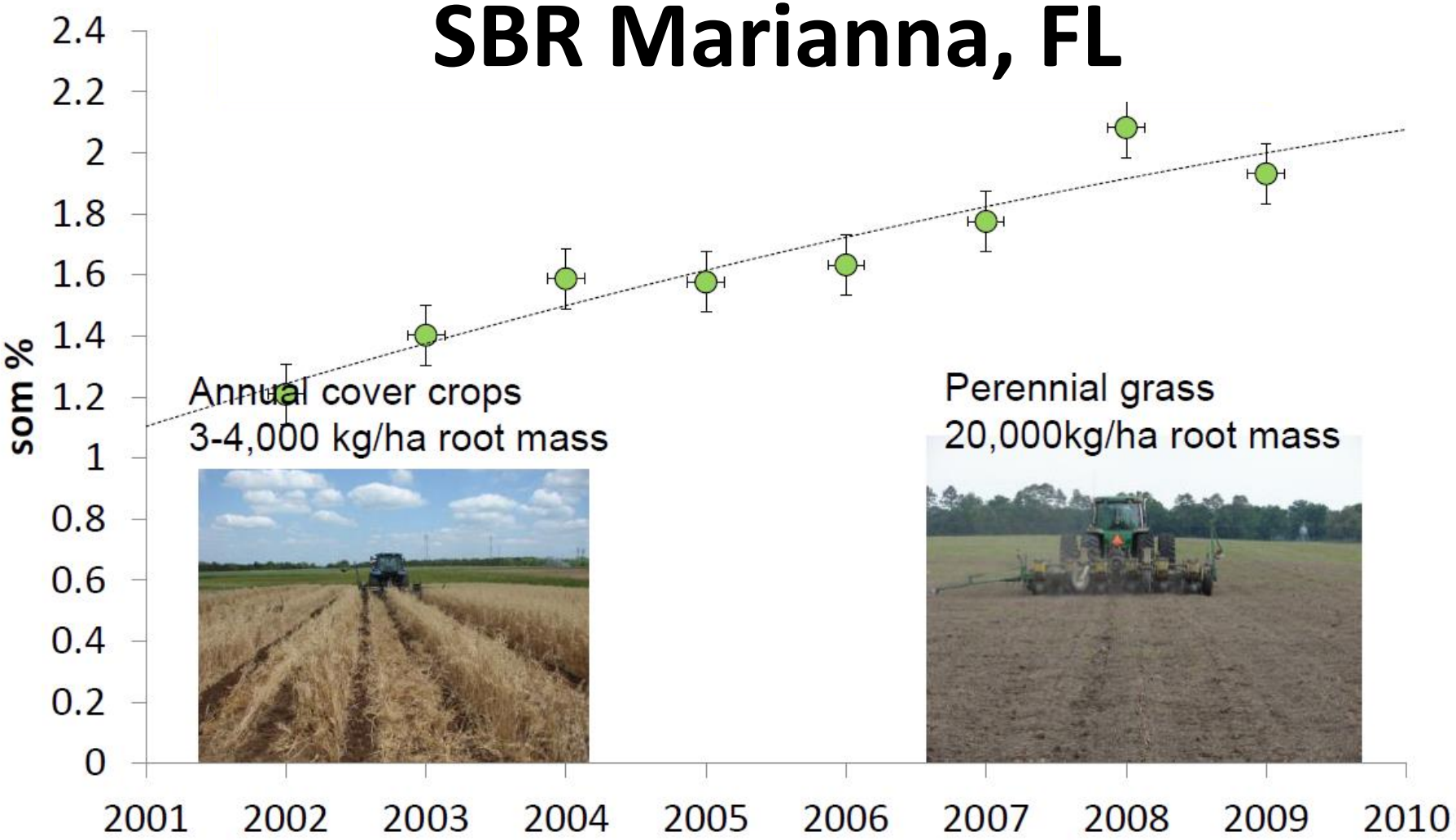
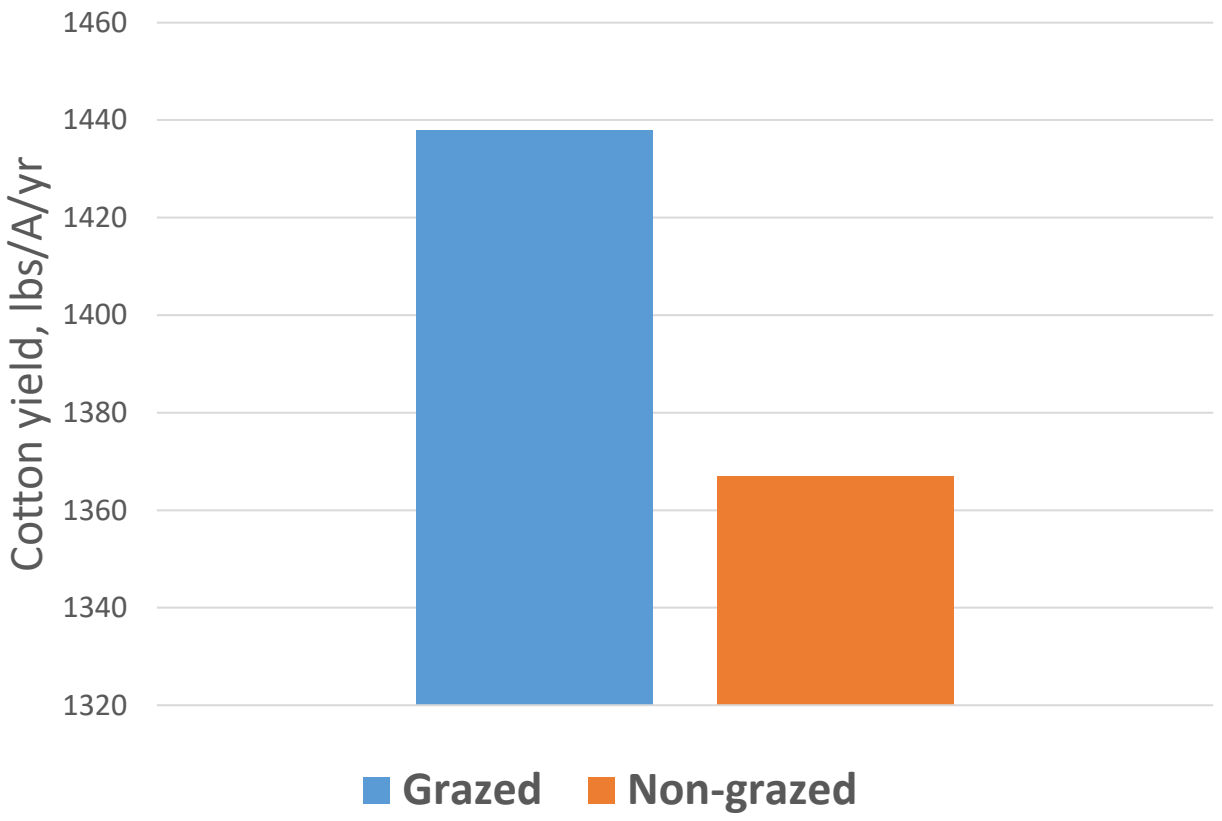
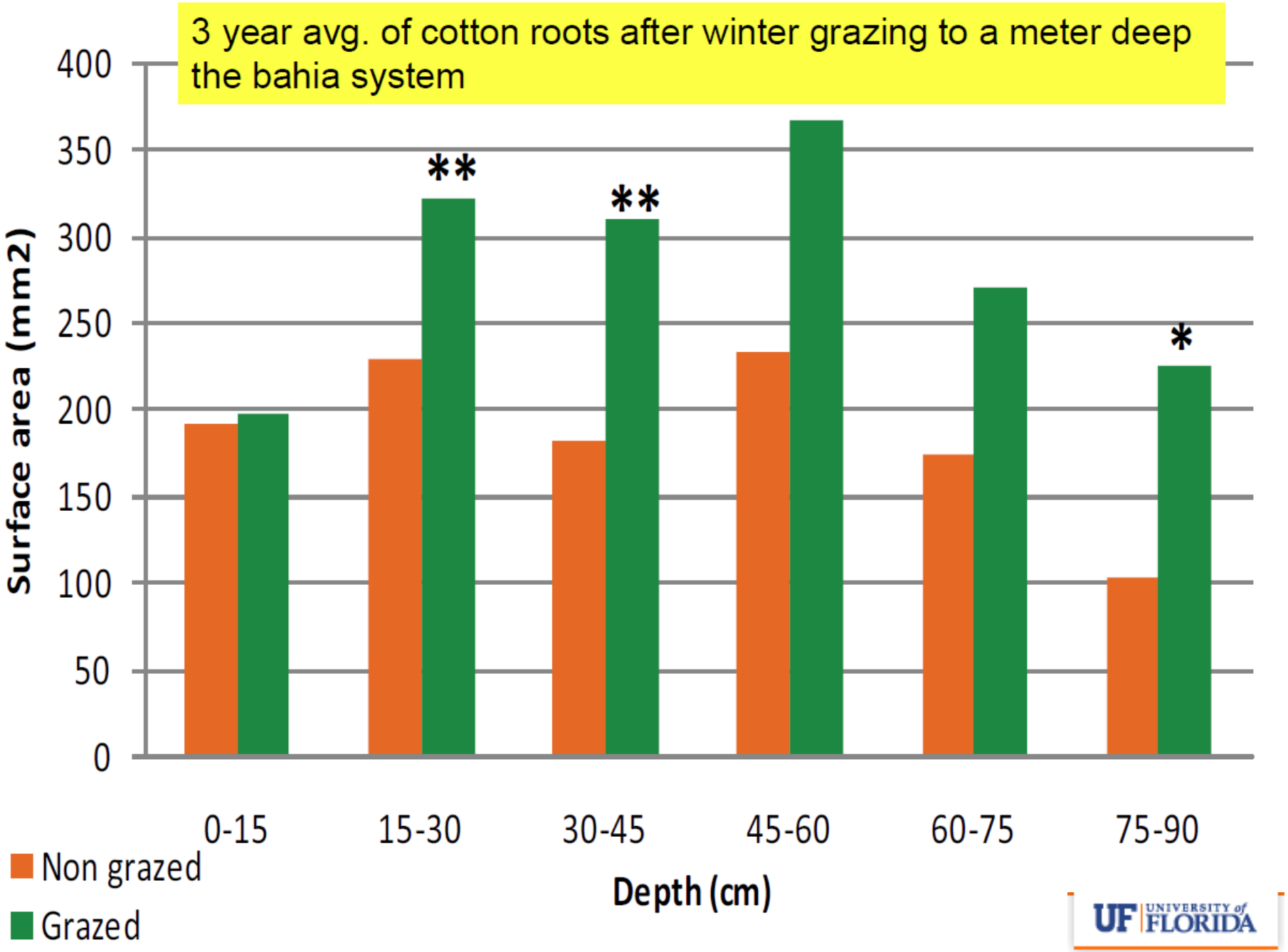
SOIL ORGANIC MATTER
SBR Marianna, FL



Cotton yield in dryland cotton (8 yrs. average) in Marianna, FL using 60 lbs N/A



Source: D. Wright (*personal communication*)


3 year avg. of cotton roots after winter grazing to a meter deep the bahia system
400
350
300
250
200
150
100
50
0
Surface area (mm2)
**
**
*
0-15
15-30
30-45
45-60
60-75
75-90
Depth (cm)
Non grazed
Grazed

Root surface area of peanuts after winter covers in a sod based rotation, 3yr. Avg. minirhizotrons

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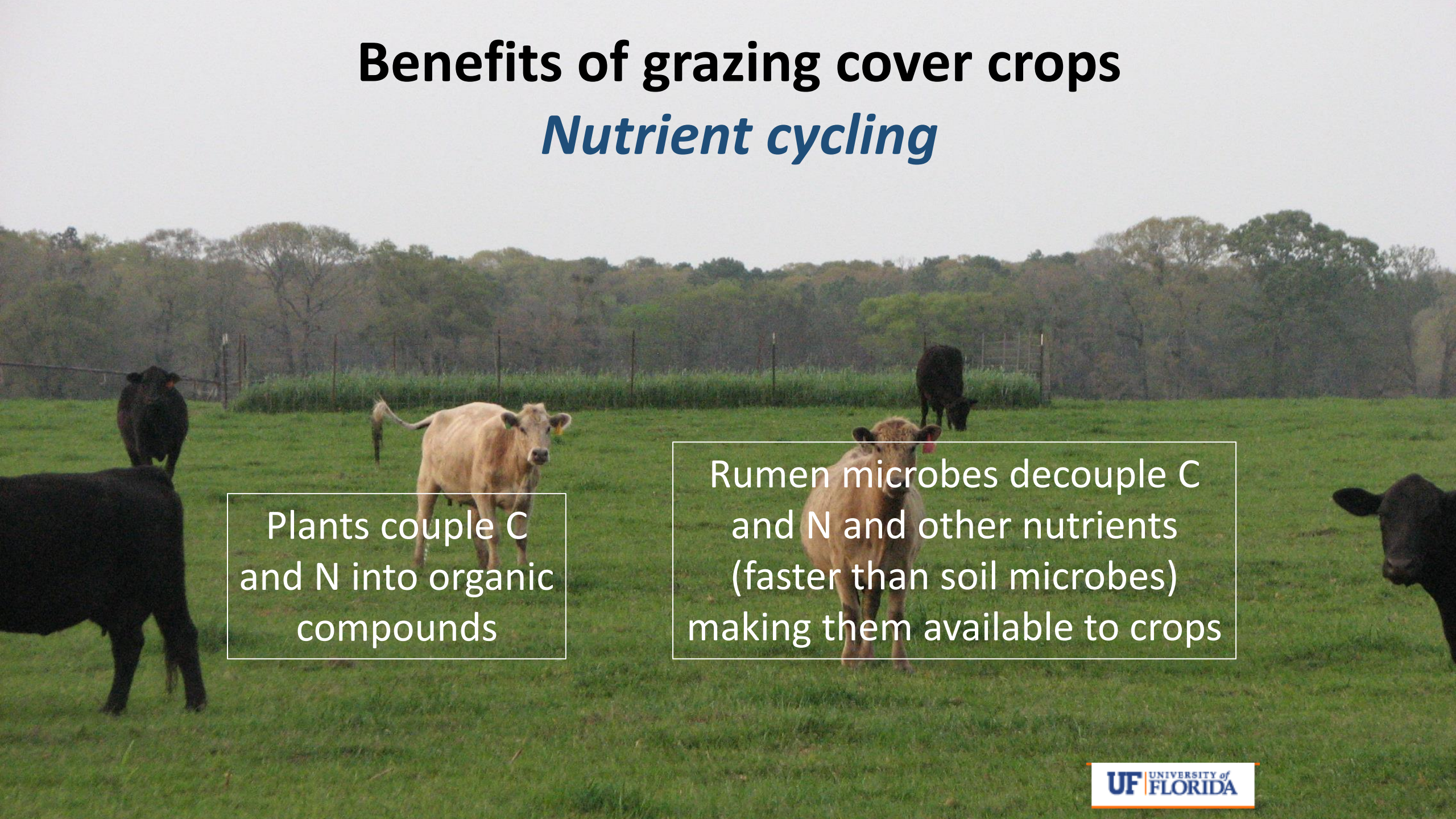
Benefits of grazing cover crops

Nutrient cycling



Plants couple C and N into organic compounds

Rumen microbes decouple C and N and other nutrients (faster than soil microbes) making them available to crops

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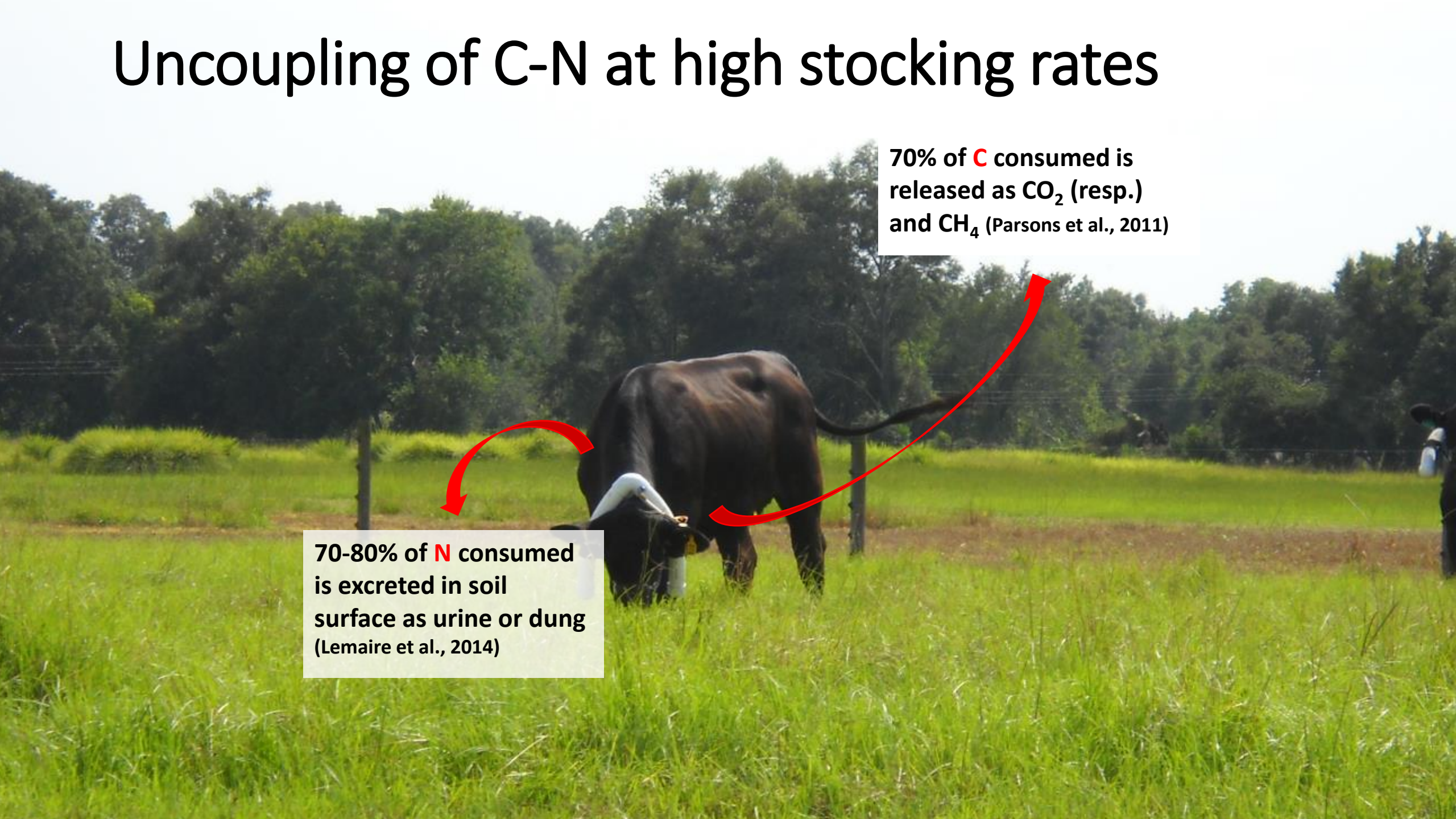
Uncoupling of C-N at high stocking rates



Rumen bugs can do in 144 h what might take 256 d in the field

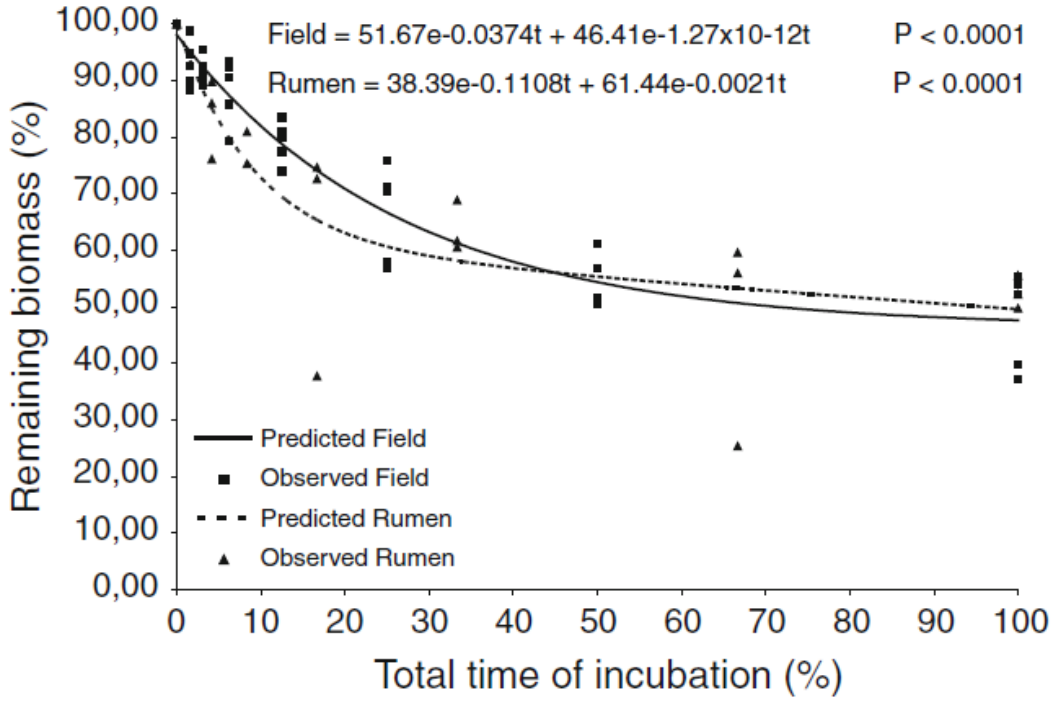


Fig. 1 Percentage of remaining biomass in the rumen and in the field (DM basis) of signal grass litter using correlated time scale; 100% in the rumen = 144 h; 100% in the field = 256 days

Silva et al. (2009)

Large-scale on-farm monitoring in the Jackson Blue Springs Basin (by A. Albertin)

Evaluate the effectiveness of the sod-based rotation system in reducing N inputs and N leaching below the crop rooting zone

- Quantify nitrogen leaching in SBR compared to conventional rotation
- Assess N loading and movement in the soil column through soil nutrient and leachate analysis

4-year paired field comparison under one center pivot

- SBR (Bahia-Bahia-Peanut-Cotton) – 120 acres
- Conventional (Peanut-Cotton-Cotton) – 55 acres

Study design

Soil zones identified through Veris mapping

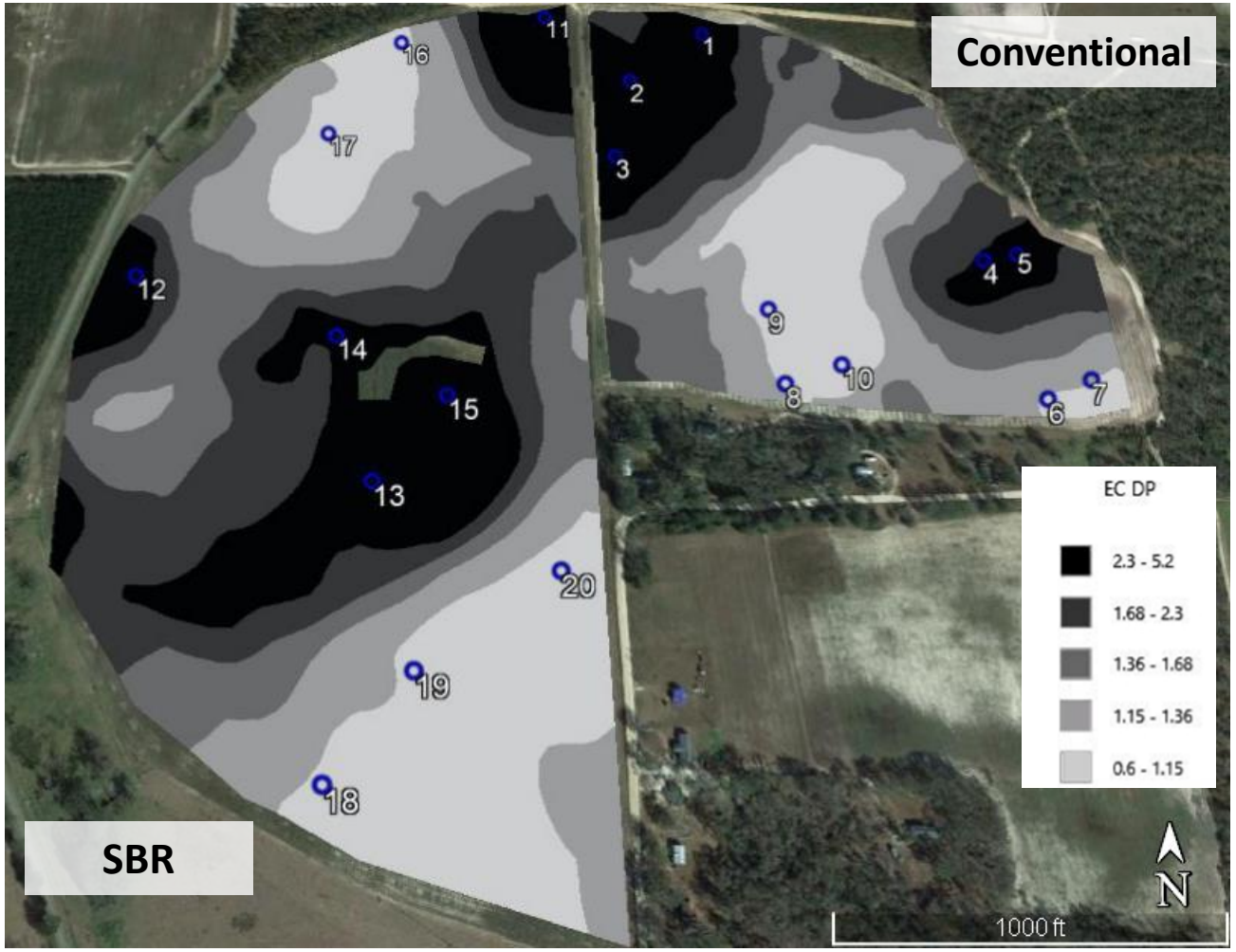
Soil Zone	EC (mS/m)
1 Dark	1.68 – 5.2
2 Light	0.6 – 1.15

10 Drain gauge lysimeters in each field

- 5 per soil zone
- Leachate analysis: NO_3-N, NH_4-N, TKN

Soils sampled at each lysimeter site

- NO_3-N, NH_4-N, TKN, %OM
- 2X/year (0-4 ft)
- YR1 and YR4 (0-18 ft)



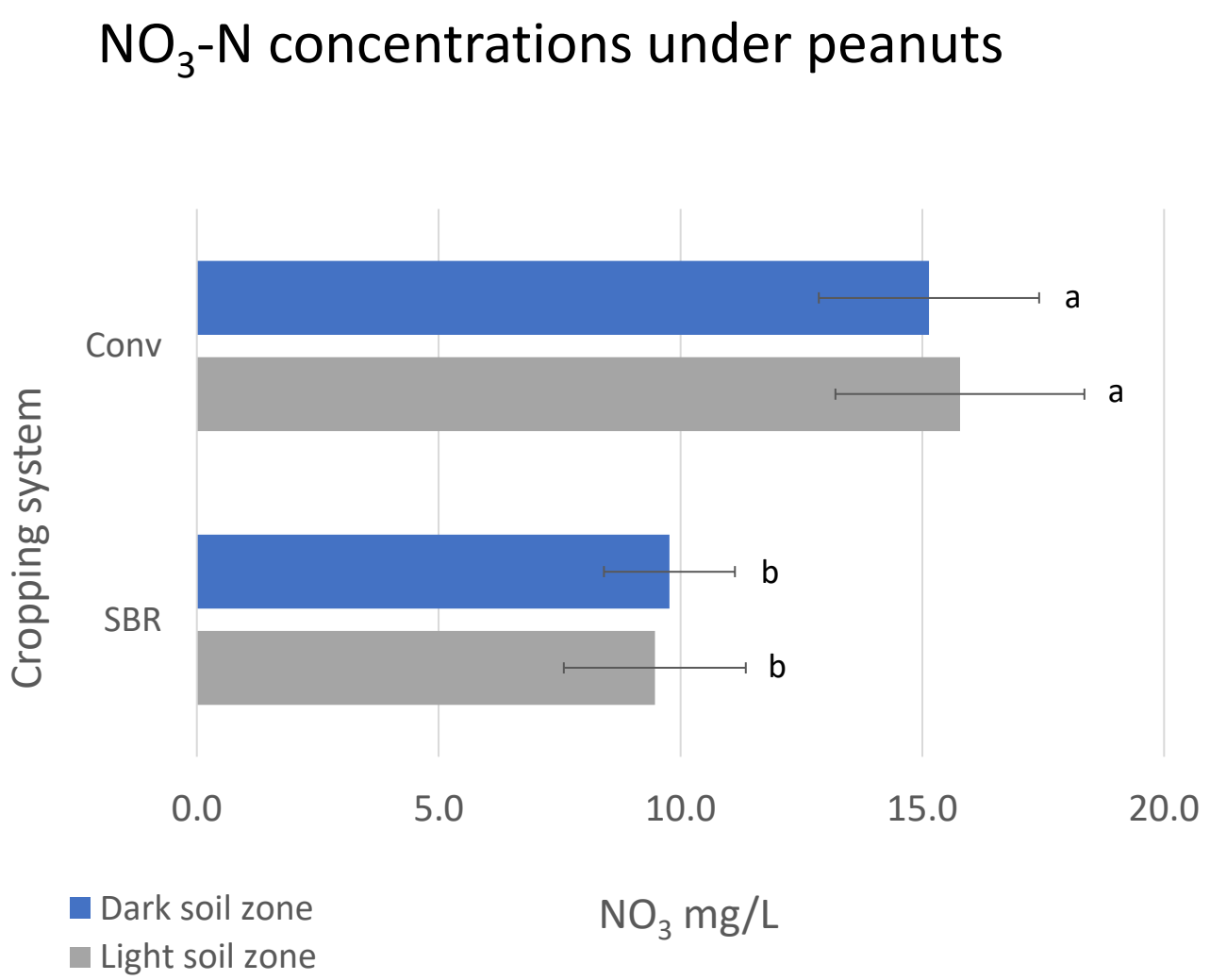


Figure 13. Mean nitrate (NO_3-N) concentrations (mg/L) in leachate under peanuts in the conventional treatment and the sod-based rotation by soil zone (dark soil zone and light soil zone). Bars represent means of 5 replicates per soil zone, and bars with different letters indicate significant differences between them. May 24-September 14, 2021

WHAT DID WE LEARN?

- Integrating a perennial grass and grazing cattle into a crop rotation helps to build soil health
- Crop yields increase
- Reduction on nitrate leaching
- Reduction on water and fertilizer needs
- Adoption still limited – social and economic reasons related to land tenure

Where Are We Heading Now?

- Integrating crops and livestock is a win-win strategy
- Where the SBR system fits, go with that!
- If for some reason it is hard to incorporate the 2-yr rotation with bahiagrass, there are other options

Integrated Systems Approach

Conventional		Integrated Crop-Livestock		Sod-Based Rotation	
Winter	**Summer**	**Winter**	**Summer**	**Winter**	**Summer**
No Cover	Cotton	Overgrazing Cover Crops	Cotton	Overgrazing Cover Crops	Overgrazing Bahia
Cover Crops + 34 N	Cotton	Mod. Grazing Cover Crops	Cotton	Mod. grazing Cover Crops	Mod. grazing Bahia
Cover Crops + 90 N	Cotton	Undergrazing Cover Crops	Cotton	Undergrazing Cover Crops	Undergrazing Bahia

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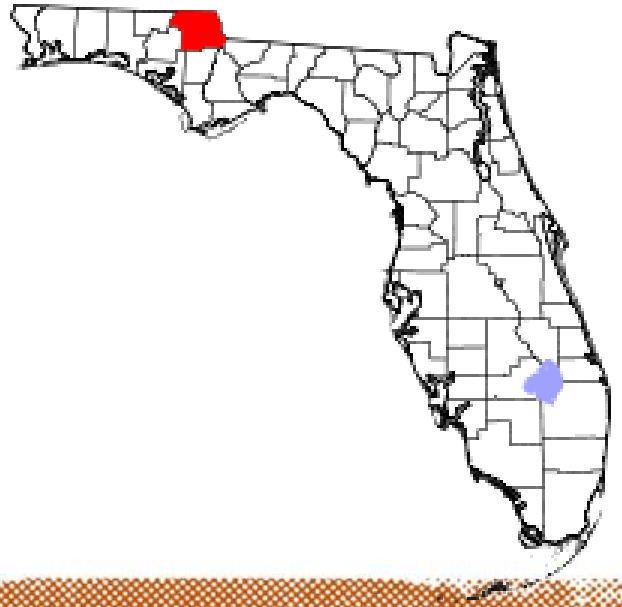
Experimental Area

- **NFREC – Marianna, FL**
- **Annual average temp. = 19.8°C**
- **Rainfall = 1361 mm**
- **Soil series**

  Red Bay fine sand loam



Cool season

Warm season

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PEANUT AND COTTON YIELD ON CONTRASTING CROP-LIVESTOCK SYSTEMS

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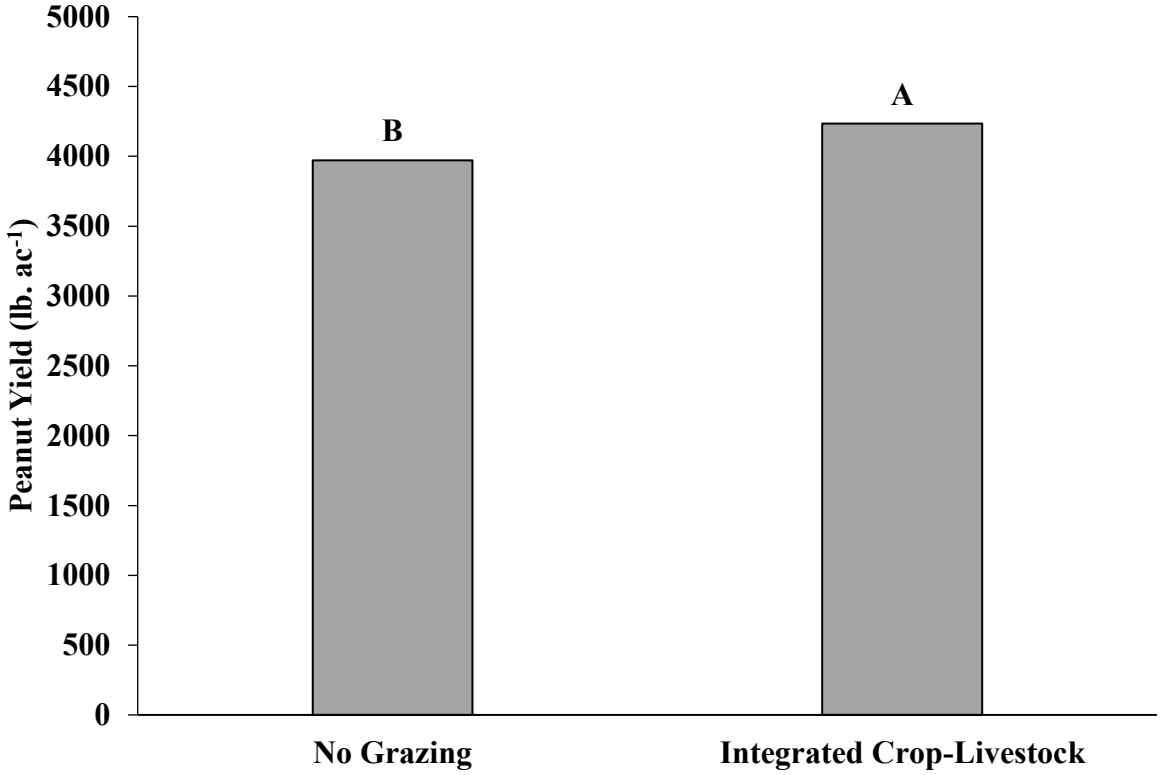
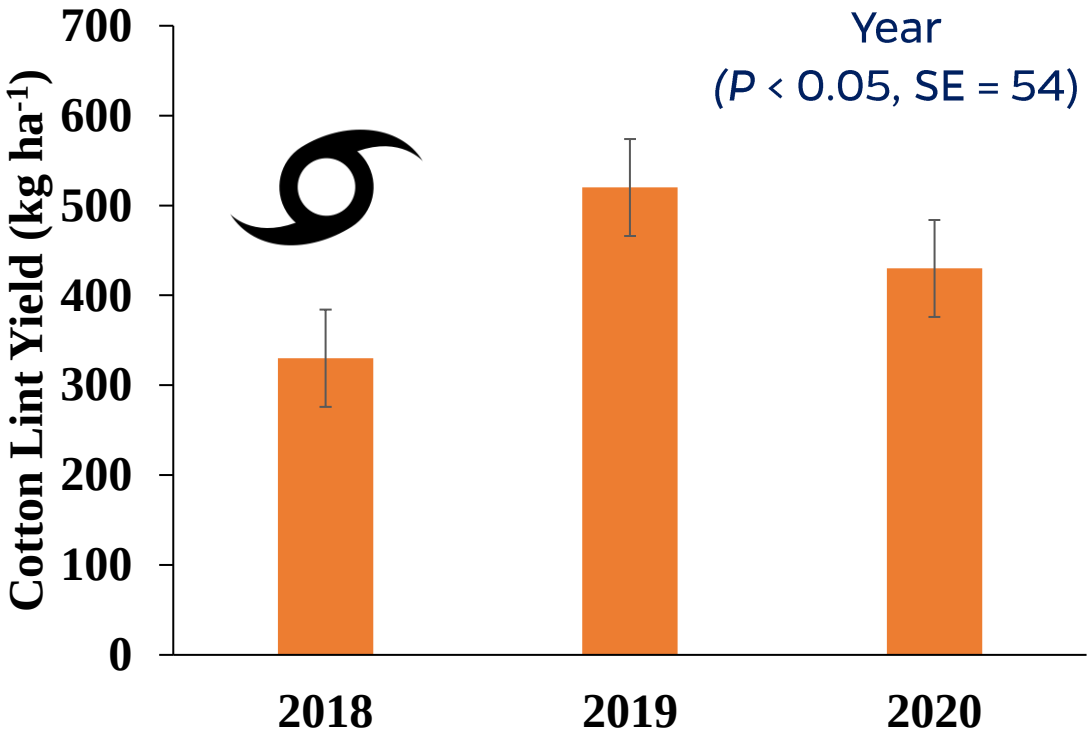
Grazed plots resulted in greater peanut yield



Contrast effect of No Grazing vs Grazing on peanut yield (P = 0.04). No Grazing = No Cover, Cover 34, Cover 90; Grazing = SBR-Over, SBR-Mod, SBR-Under, ICL-Over, ICL-Mod, ICL-Under.

Cotton Lint Yield



Average cotton lint yield = 880 kg ha^{-1} (Katsvairo et al., 2007)

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NITROGEN LEACHING ON CONTRASTING CROP-LIVESTOCK SYSTEMS

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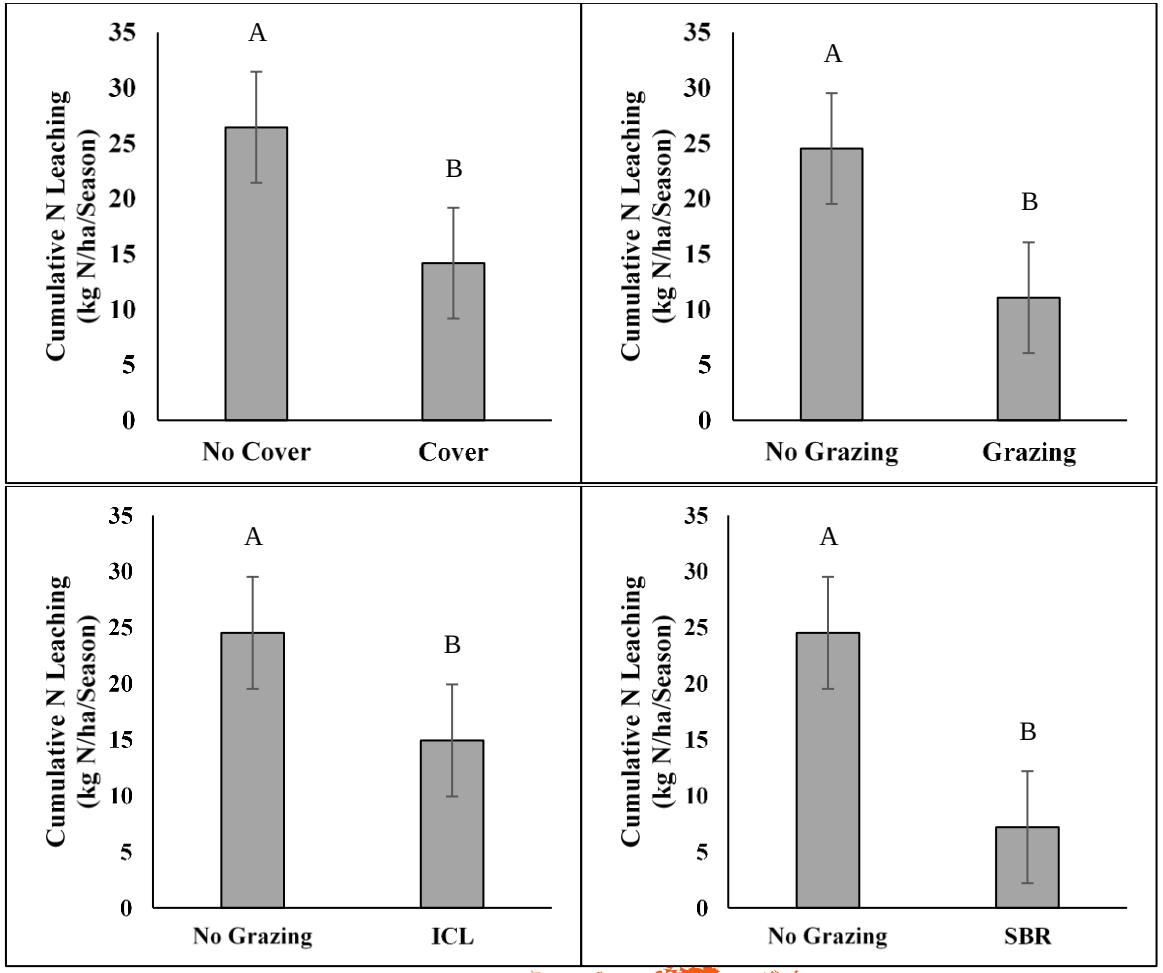
The Best	The Good	The Ugly
Grazing cover crop	Cover crop (no grazing)	Fallow



Contrast effect on cumulative total N leaching of different cropping systems. Average of three years and two seasons

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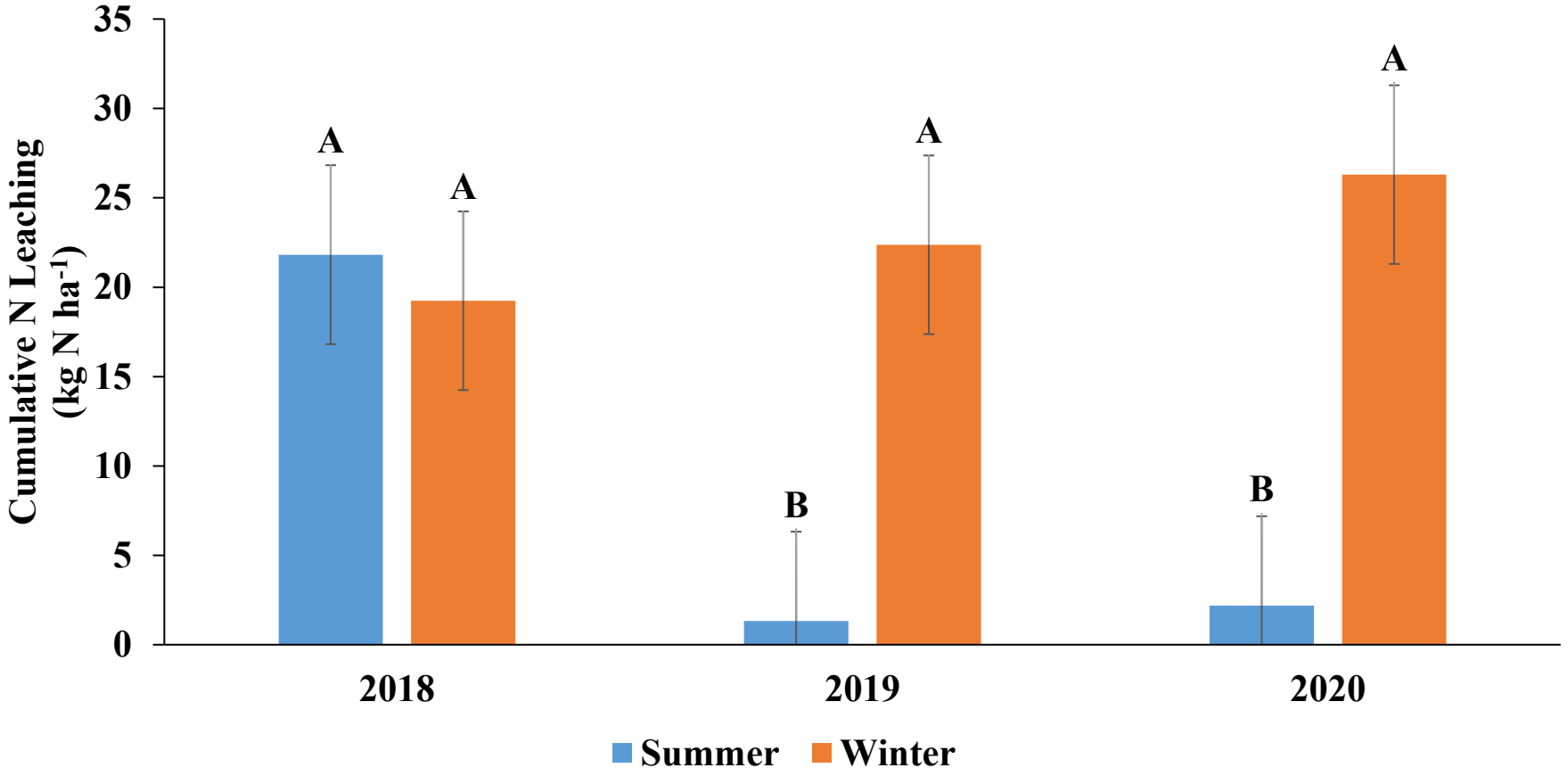

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Belowground cover crop litter is more important than aboveground one

Treatment	Aboveground Litter N Disap.	Belowground Litter N Disap.
	kg N ha^{-1}	
No Grazing + 34N	6	21^{b}
No Grazing + 90N	12	39^{a}
Overgrazing	11	27^{ab}
Mod. Grazing	10	34^{ab}
Undergrazing	13	36^{ab}
Standard Error	3	5
P-value	0.24	0.02

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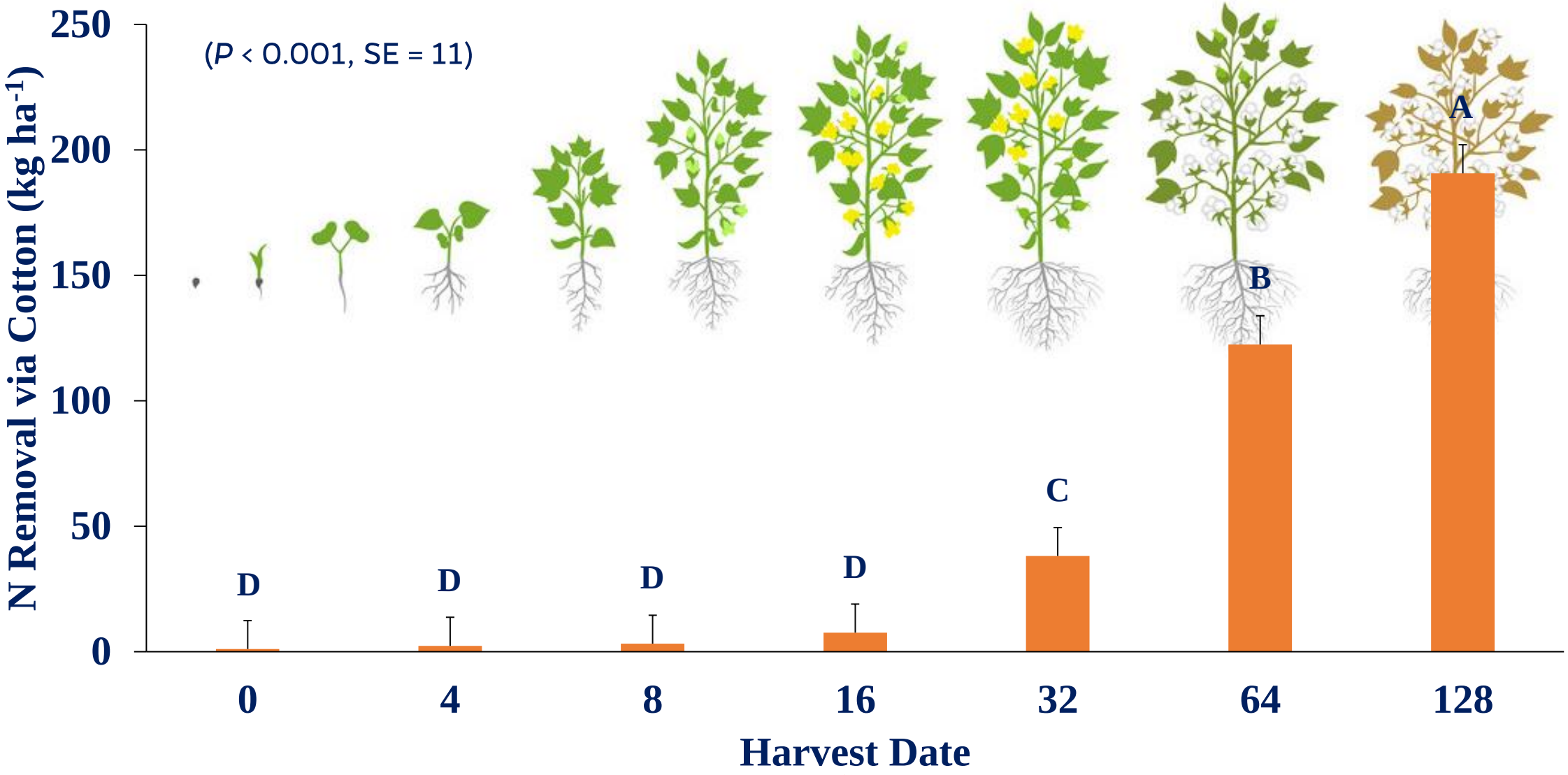

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Cover crop reduced compaction

Grazing did not increase compaction

Contrast	Soil Bulk Density
	P value
Cover vs. No Cover	**0.031**
Grazing vs. No Grazing	0.576
SBR vs. ICL	0.654
No Grazing vs. ICL	0.438
No Grazing vs. SBR	0.833
Group Mean	**g cm^{-3}**
Cover	**1.49**
No Cover	**1.72**
Grazing	1.50
No Grazing	1.54
SBR	1.52
ICL	1.48

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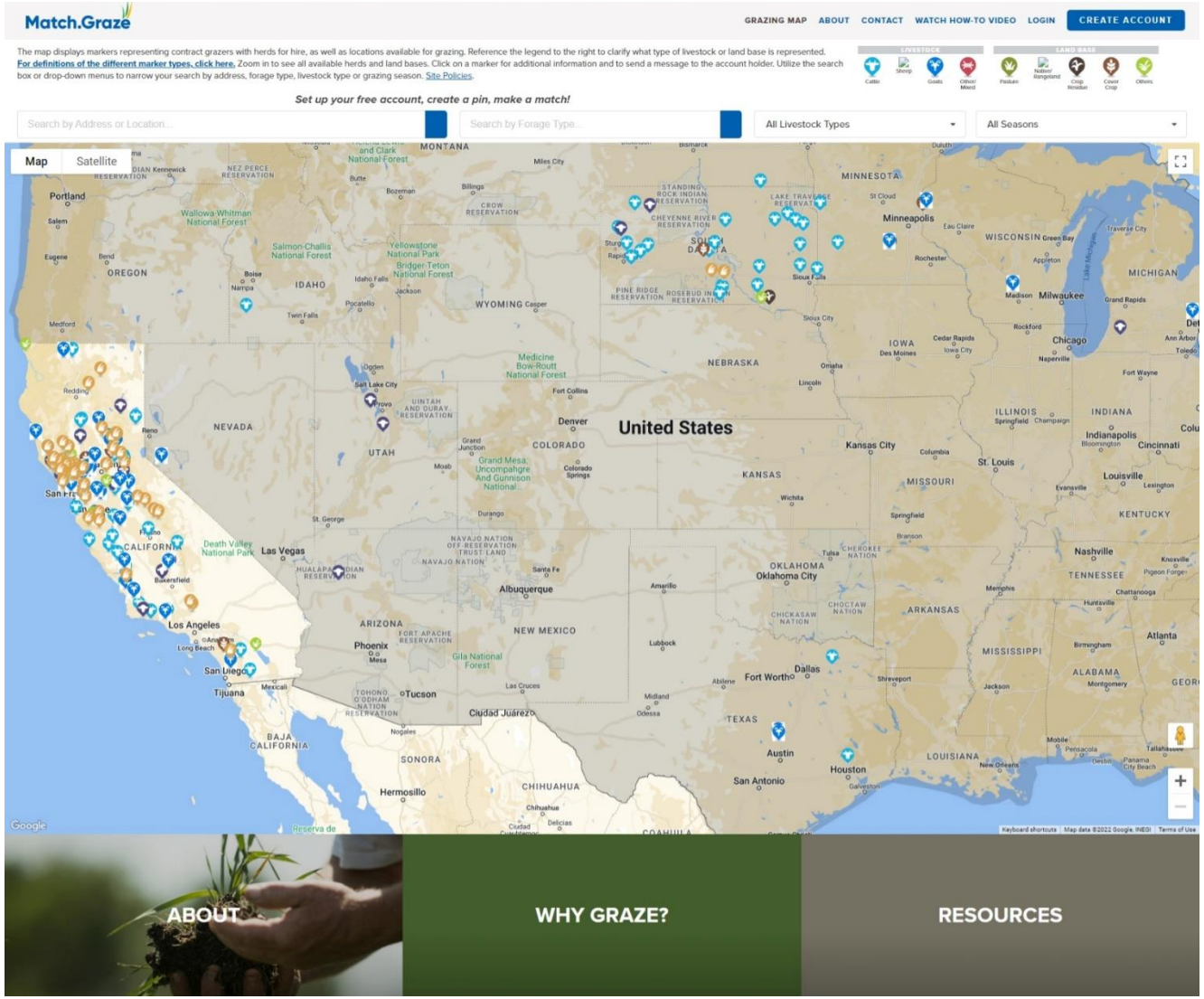
IN SUMMARY

- Integrating crop and livestock systems, even without a 2-yr rotation with bahiagrass, also added benefit to the system
- Fostering collaboration is important to increase adoption
- We believe that crop farmers need to partner with livestock producers
- Some succesful examples already exist

Matching producers with different needs



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TAKE HOME MESSAGES

- Integrated crop-livestock systems are a win-win strategy for row crop farmers, cattle producers, and the environment
- Need to implement policies to facilitate partnership and increase adoption
- Main barriers to overcome are related to perimeter fencing and related infrastructure to implement grazing
- Educational programs to increase awareness

ACKNOWLEDGEMENTS

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