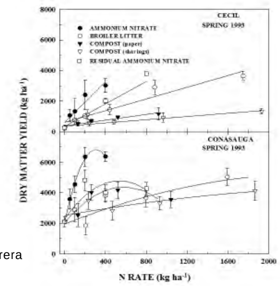
Nutrient Distribution and Tactics to Manage Grazing Behavior

Dr. Dory Franklin,
Sustainable Agriculture Management,
Department of Crop & Soil Sciences,
University of GA

Go DAWGS!

Why Nitrogen, Phosphorus and Carbon?

Nitrogen



Tyson and Cabrera

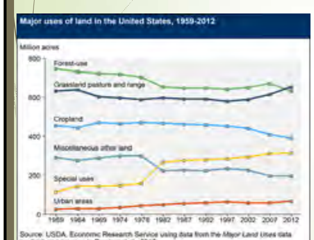
Fine, kaolinitic, thermic Typic Kanhapludults

Total N	Total C	Melich-I P	Exchangeable K
------- g kg^{-1} -		---------- mg kg^{-1} ------	
2.0	20.1	94	135

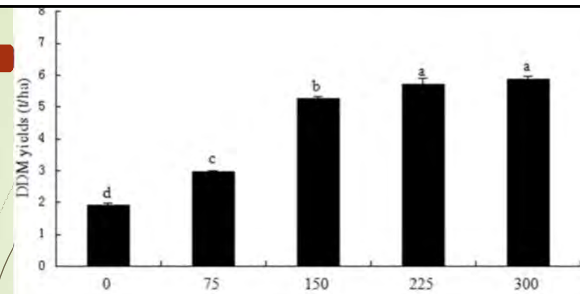
Fine, mixed, semiactive, thermic Oxyaquic Hapludalfs

Total N	Total C	Melich-I P	Exchangeable K
------- g kg^{-1} -		---------- mg kg^{-1} ------	
1.2	13.6	62	342

Grazing Systems are Important to Agricultural Sustainability of the Southeastern USA



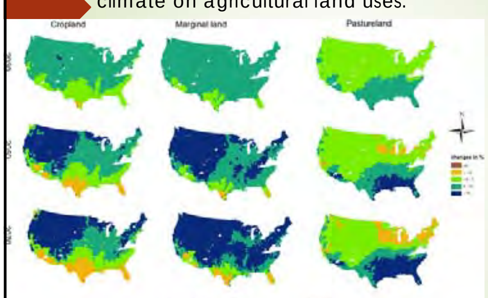
- Throughout the world, grazing systems cover more than a quarter of the earth's land surface (Asner et al., 2004) and
- Loss of nutrients (N, P, C) from pastures is an unsolved problem to which fertilizer N, climate conditions, grazing density and supplemental forage and feed contribute
- Importance in Southeastern USA will grow according to predictions



Effects of N application rates on digestible dry matter (DDM) yield.
Different lowercases letter indicate significant differences at $p<0.05$ level and error bar shows standard error of data.

Li et al. (2016) Asian Australas. J. Anim. Sci. 29:1129-1135

Temporal and spatial distributions of impacts of future climate on agricultural land uses.



By 2030:
Magnitudes of land-use changes on average will be small, around 10%

By 2070:
Northern USA and the intermountain western USA will show increased cropland (where it will become warmer and wetter)
Southeastern USA will show increased Pastureland (where it will be hotter and moisture less predictable).

All changes in land uses are averaged over 20 global climate model projections for two emission scenarios.

What impacts Nutrient Distribution?

- Fertilization
- Climate conditions
- Grazing density
- Supplemental forage and feed
- Grazing can improve carbon, phosphorus, and nitrogen storage and utilization depending on management and environment

Our Objectives

- To assess the spatial variability of soil inorganic nitrogen and to quantify:
  - Effects of management activities, cattle locus, and landscape parameters,

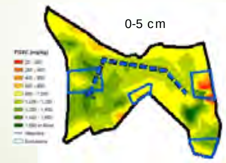
Settings

- In a multi-location, typical farm-size setting via extensive grid-soil sampling and use of sophisticated GIS technologies.

Carbon Distribution

Active Carbon in Conventional/Continuous Grazing

- Large pastures continuously grazed with little (a few times a year) or no rotation
- Often a few permanent waterers
- Often hay feeding areas are located in "sacrifice" part of pasture



- There is non-uniform distribution of Carbon in the pasture

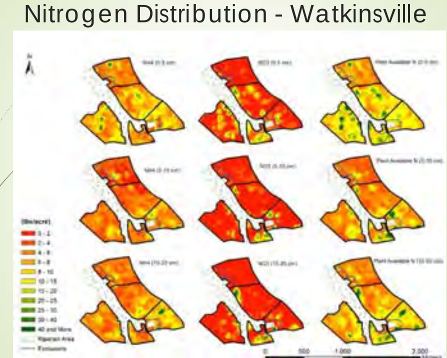
- Cattle tend to stay close to the shade, water and hay
- Where cattle congregate, nutrients can build up when landscape conditions are favorable

- Nutrients deposited in low-lying areas, vulnerable to erosion (concentrated flow areas), are washed away in runoff water

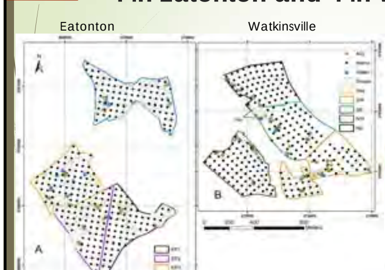
Which of these factors are Influencing N, P, and C distribution in GA Piedmont Grasslands?

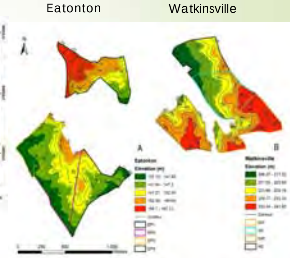
- Main factors are feeding of hay, water, shade, and where those are in the landscape.
- Today we will talk about carbon and nitrogen, but phosphorus follows similar patterns.

Nitrogen Distribution - Watkinsville



Eight Pastures: 4 in Eatonton and 4 in Watkinsville

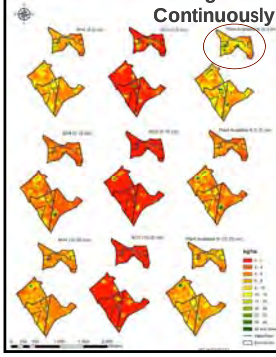




Study sites showing the pasture delineation, location of hay, shade and water, and sampling

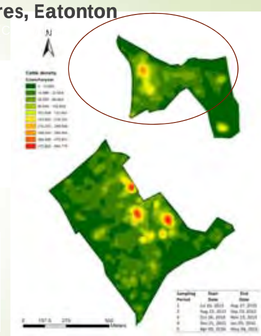
The map unit is meters and the projection system is NAD 1983 UTM Zone 17 N

Distribution of Inorganic N (Plant Available) and Cattle Density in Continuously grazed pastures, Eatonton



Left, Ammonium + Nitrate = Plant Available N in Eatonton Pastures (at three different soil depths):
0-5 cm (0-2 in),
5-10 cm (2-4 in), and
10-20 cm (4-8 in)

Right, Cattle Density map for July 2015 to April 2016 using GPS collars to mark cattle location every 5 minutes for 28 days.



Which factors influenced Soil Plant Available Nitrogen?

	Eatonton			Watkinsville		
Model	Multiple Reg	Multiple Reg	Multiple Reg	Spatial Lag	Spatial Lag	Spatial Lag
	0-5 cm	**5-10 cm**	**10-20 cm**	**0-5 cm**	**5-10 cm**	**10-20 cm**
Intercept	0.78*	1.46**	0.98***	2.41***	2.01***	1.40***
Cow Density	0.14***	0.04	0.07**			
Hay location	0.22**	0.12	0.17*	0.21	0.34***	0.34***
Shade	0.25***	0.17**	-0.22**	0.65***	0.64***	0.14*
Water	0.04	0.66***	-0.01	-0.26***	-0.30***	-0.42***
BD05	-0.24*	-0.28**	0.00	-0.16*	0.25***	0.24**
BD510	-0.30**	0.12	0.09	-0.12	-0.29**	-0.06
BD1020	0.04	0.09	-0.04	0.05	-0.28*	-0.11
n	233	233	233	255	255	255

How can we use this information to better utilize Nutrients more Productive and Efficient (Sustainable) Grazing Systems

- Dennis Hancock, Lawton Stewart, NRCS, Participating Producers and myself developed a management system which utilizes a ***Mixture of better grazing practices called***
- **Strategic-rotational grazing**

Distance to which Management factor increased Plant Available Nitrogen

	Eatonton			Watkinsville		
	0-5 cm	**5-10 cm**	**10-20 cm**	**0-5 cm**	**5-10 cm**	**10-20 cm**
Hay, m (feet)	28 (92)	83 (272)	54 (177)	44 (144)	27 (89)	29 (94)
Water, m (feet)	91 (298)	100 (330)	91 (298)	100 (330)	25 (82)	100 (330)
Shade, m (feet)	4.5 (15)	4.5 (15)	100 (330)	3.6 (12)	11 (36)	100 (330)

What is Strategic-Rotational Grazing?

Mixture of better grazing practices

1. Manure distribution through **Lure management** of cattle
  a) Portable shades
  b) Portable waterers
  c) Portable hay rings

2. Exclusion of compacted areas vulnerable to nutrient loss

3. Over seeding of exclusions with forage mix

4. Flash/Mob grazing of excluded areas for short time

5. Moderate rotational grazing in the sub-paddocks

Conclusions

- A typical continuously grazed pasture is prone to uneven spatial distribution of inorganic N with greater soil N concentrations near water, hay, or shade.
- The uneven spatial distribution was evident even at 20 cm depth suggesting a need to move pasture equipages on a regular basis.
- The cattle density in a conventionally grazed pasture indicates that cattle spend the majority of their time near one or more of pasture equipages.
- Slopes within pastures can have a significant negative effect on the amount and spatial distribution of inorganic N.

Methodology

Study Sites

Stocking Density: 2.5 Cows per Acre (1.2 Cows per Hectare)

Fig: North Unit of J. Phil Campbell Sr. Conservation Research and Education Center of The University of Georgia, GA

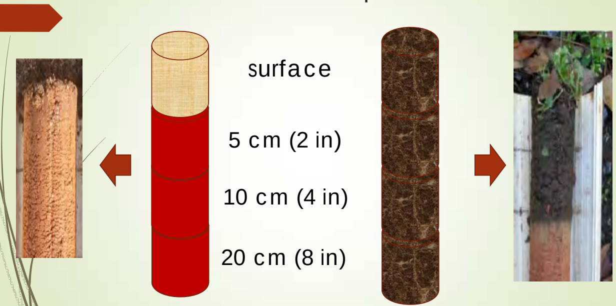
Fig: West Unit of J. Phil Campbell Sr. Conservation Research and Education Center

Fig: Animal Sciences and Dairy Cattle Beef Cattle Farm in Eatonton, GA

Getting the Cows to work for us…

Rather than sacrificing area we hope to regenerate areas with less productivity

How much rainfall can we capture?



Project Goal: to **redistribute the nutrients** for better overall **forage productivity** and **reduced nutrients in runoff** from the pastures

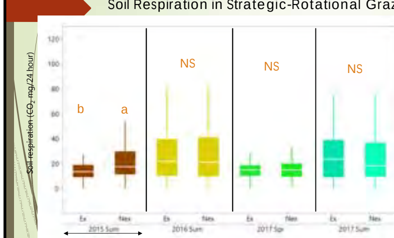
Specific Objectives

- To compare the strategic-rotational grazing vs. conventional grazing in terms of **Soil Health**
- To compare the strategic-rotational grazing vs. conventional grazing in terms of **Runoff-nitrate**
- To compare the strategic-rotational grazing vs. conventional grazing in terms of **Forage-Productivity**

Post portable shade

Results – Soil Health

Soil Respiration in Strategic-Rotational Grazing



During the baseline, the respiration was significantly higher in the areas that were going to be excluded suggesting uneven soil respiration

Exclusion

Sampling Time

Fig. Comparison of Soil Respiration in exclusion vs. non-exclusion areas before (2015 Sum) and after treatment.
Different letters represent statistical difference between groups at P=0.05. NS: Not Significant difference between groups.
Ex: Exclusion area; Nex: Non-Exclusion area

After the treatments, the excluded areas and the rest of the pastures did not differ significantly in terms of soil respiration

Thanks to the forage mix that was planted in the exclusions.

Results – Soil Health

Soil Respiration

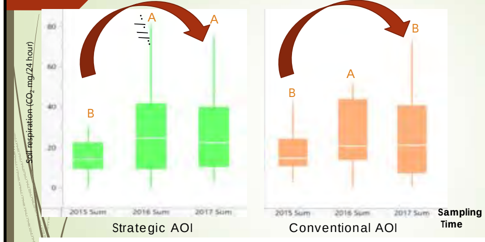


Fig. Comparison of Soil Respiration in Areas of Interests (AOIs) in Strategic vs. Conventional pastures before (2015 Sum) and after treatment.

Different letters represent statistical difference between groups at P=0.05.

Conclusions

- After the implementation of Strategic-grazing**,** the AOIs were improved in terms of soil respiration and the matrix was improved in terms of potentially mineralizable Nitrogen
- **Forage productivity was improved** in the strategic-rotational grazing pastures as compared to conventionally grazed pastures (during a long drought period)
- Runoff-Nitrate was **1/4th** in the Strategic Pastures as compared to the Conventional pastures during extreme event (Hurricane Irma)
- These results suggest that Strategic grazing can be useful tool for **improving sustainability** of beef pastures and **building resistance** against extreme events

Results – Soil Health

Potentially Mineralizable Nitrogen in Strategic Pastures

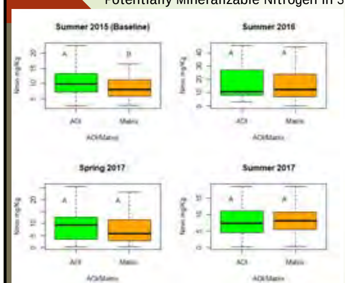
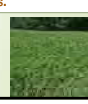


Fig. Comparison of Potentially mineralizable Nitrogen in AOIs vs. Matrix in the Strategic Pastures at different sampling periods.
Different letters represent statistical difference between groups at P=0.05.

- **During baseline (2015), potentially mineralizable N was significantly higher in the AOIs as compared to the Matrix.**
- **After the treatment (Strategic Grazing), the difference in Potentially mineralizable N was not significant.**

- **We believe that the forage in over-seeded AOIs was able to utilize the abundant Nitrogen in the absence of cows.**
- **The forage was then flash grazed which allowed the cows to redistribute the Nitrogen to the Matrix through feces.**

Results – Runoff Water

Nitrate Concentration in Runoff After Treatment

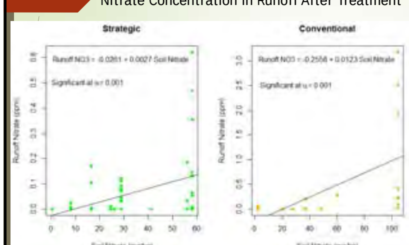


Fig. Comparison of Nitrate Runoff from Strategic vs. Conventional Pastures in Summer 2017 with respect to soil Nitrate (mg/kg)
Different letters represent statistical difference between groups at P=0.05

- **Significant relationship between soil nitrate and runoff nitrate was observed in both Strategic and Conventional pastures.**
- **For same increase in soil-nitrate, 4.5 times less runoff-nitrate was observed in Strategic pastures as compared to Conventional pastures.**

- **This might be attributed to uptake of soil-nitrate by plants in the excluded areas of Strategic pastures.**
- **Also, restricted access of cattle due to exclusions of the concentrated flow areas resulted in less feces deposition.**