2013 Georgia Grazing School:

Soil fertility and nutrient cycling in grazing systems

Soil Fertility in Grazed Systems

GRASS

Dr. Dennis Hancock
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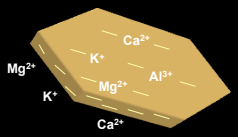
How Soil Holds Nutrients

Soil Particle



e.g., CEC = 10

Organic Matter

e.g., CEC = 200

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Plant Nutrients

Macro- (Primary)

Element	Available Form
Oxygen	O_2, OH^-
Carbon	CO_3^{-2}, HCO_3^-, CO_2
Hydrogen	H^+, OH^-
Nitrogen	NO_3^-, NH_4^+
Phosphorus	HPO_4^{-2}, $H_2PO_4^-$
Potassium	K^+

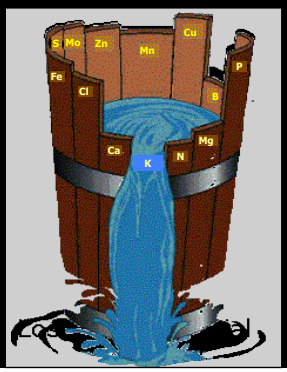
Meso- (Secondary)

Element	Available Form
Calcium	Ca^{+2}
Magnesium	Mg^{+2}
Sulfur	SO_4^{-2}

Micro- (Trace)

Element	Available Form
Iron	Fe^{+2}, Fe^{+3}
Copper	Cu^{+2}, Cu^+
Zinc	Zn^{+2}
Manganese	Mn^{+2}, MnO_4^-
Molybdenum	$HMoO_4^-$, MoO_4^{-2}
Boron	H_3BO_3, $B_4O_7^{-2}$
Chlorine	Cl^-

Liebig's Law of the Minimum



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Soil Test and Follow Fertility Recommendations

Sample hay and crop fields every year and 1/3 of your paddocks each year.

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Soil Sampling

- Probe, shovel
- Sample to 4 inches.
- Discard thatch/duff.
- Collect samples in clean, plastic container.
- Mix, remove debris, split the sample if necessary.

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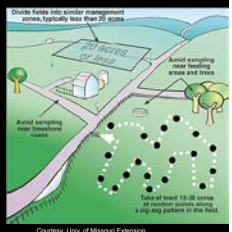
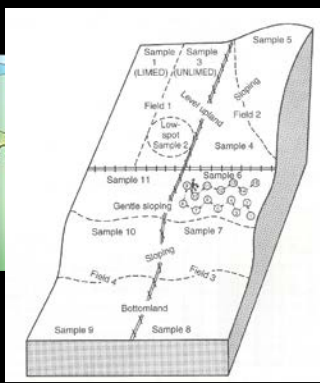
Sampling is Critical

- A soil test is no better than the soil sample submitted for analysis.
- Sampling error is the most common source of error in soil test results.
- The goal of soil sampling is to obtain a representative sample for each paddock or management area.

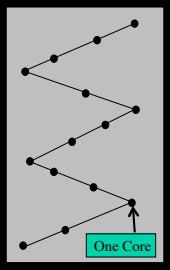
Sample Individual Paddocks



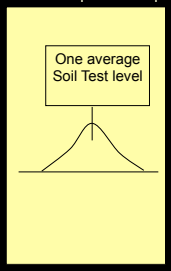


Field Average Sampling

Random Composite Sample

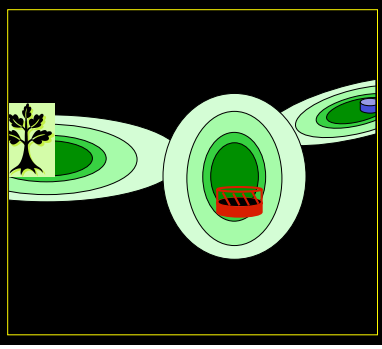


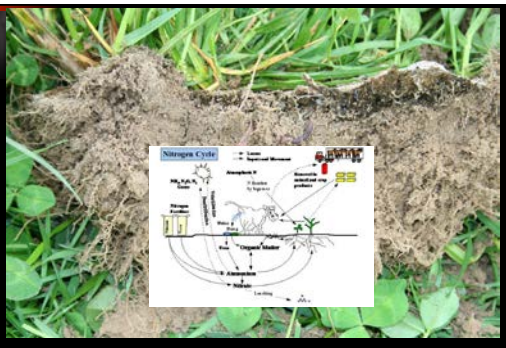
Random Composite Sample



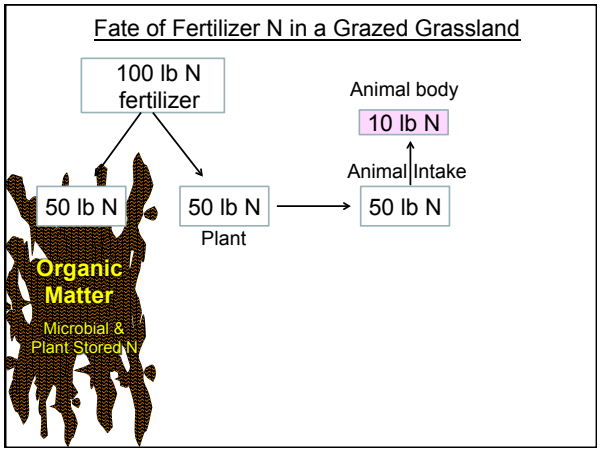
- Take 20-40 ***random*** samples for each 10 acres.
- Avoid areas near shade, troughs, trails.

Soil Sampling in Pastures





"What's in the soil, is in the plant, is in the animal, …."



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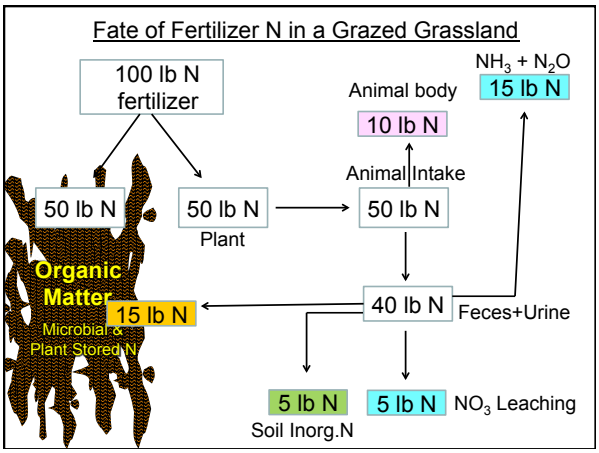


Organic N accumulation rate in upper 12 inches of soil during 12 years of haying or grazing with a yearly application of 220 lb N/acre as NH_4NO_3.

Treatment	Management	Organic N accumulation
		lb N/acre/year
Hayed	Monthly cuts to 2 inches	51 (23%)
High Grazing Pressure	Maintained at 1300 lb/acre	92 (42%)
Low Grazing Pressure	Maintained at 2600 lb/acre	122 (56%)

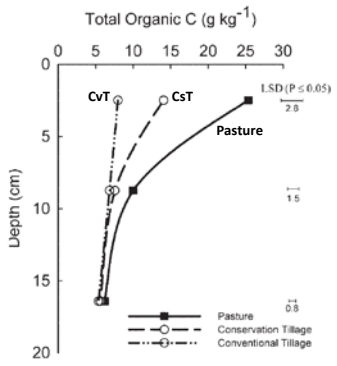
Franzluebbers and Stuedemann (2009)

Organic N accumulation rate in upper 12 inches of soil during 12 years of haying or grazing with a yearly applications of 230 lb N/acre as broiler litter.

Treatment	Management	Organic N Accumulation
		lb N/acre/year
Hayed	Monthly cuts to 2 inches	78 (34%)
High Grazing Pressure	Maintained at 1300 lb/acre	174 (76%)
Low Grazing Pressure	Maintained at 2600 lb/acre	182 (79%)

Franzluebbers and Stuedemann (2009)

Pasture vs. Conservation Tillage (CsT) and Conventional Tillage (CvT)



Causarano et al., 2008.
Soil Sci. Soc. Am. J. 72:221-230

Improvement in soil OM in 3 paddocks located in a pasture-based dairy in Wrens, GA. (2007-2009)

Paddock	Initial	1 year	2 years	3 years
	------ *Soil Organic Matter, %* ------			
P4	1.08	1.15	1.25	2.20
P8	1.01	1.17	1.59	2.18
P14	1.14	1.63	1.86	2.00
Avg.	**1.07**	**1.32**	**1.57**	**2.13**

3 years after grazing system started, averaging an inc. in soil OM of 0.35 percentage points per year!!!

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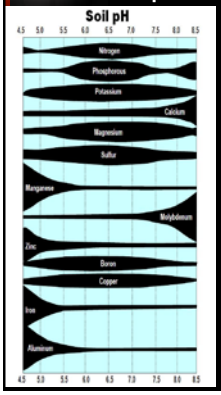
Get your priorities right!

Maintaining soil pH is job #1.

- Nutrient availability
- Soil structure
- Soil biological activity
- Aluminum toxicity

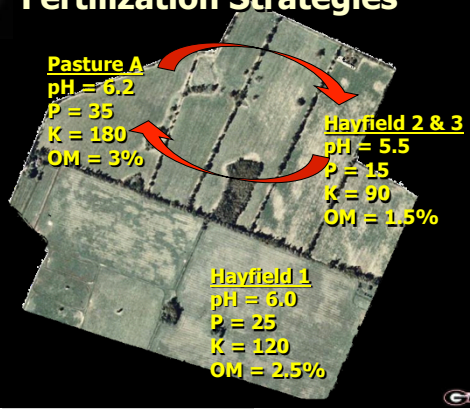
How Soil pH Affects Availability of Plant Nutrients



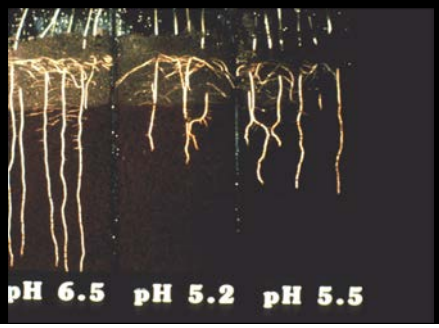
The difference of a soil pH of 5.6 vs. 6.2:

Nutrient	Amt. Used Annually (Lbs/acre)	Unit Price ($/lb)	Dec. in Efficiency	Value of Decrease ($/acre)
N	200	$0.70	35%	-$49
P_2O_5	50	$0.58	50%	-$15
K_2O	150	$0.55	10%	-$8
			Total	-$72

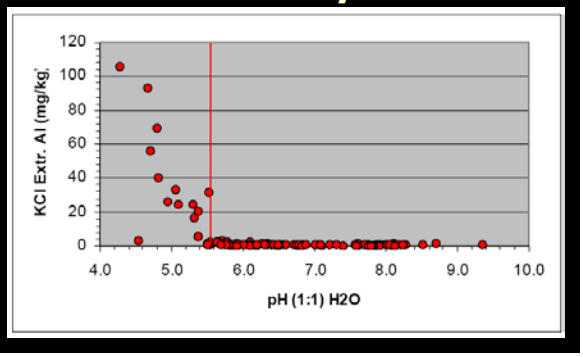
Fertilization Strategies



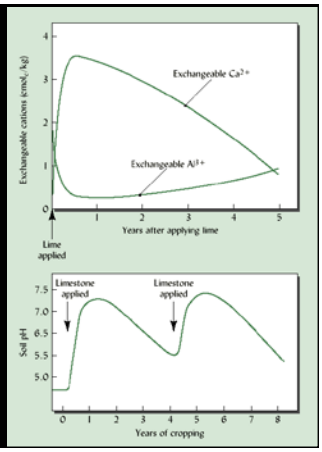
Get at the Root of a Problem: Soil pH Problems



Low Soil pH = Aluminum Toxicity



Applications of lime every 3 to 4 years are needed in Southeastern soils to maintain appropriate chemical balances in the soil.



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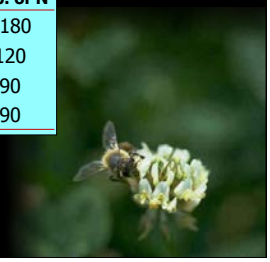
Split Your Nitrogen Applications!

- Long-term, this can increase yields by **5-10%** and increase NUE by **25-30%**
  - Especially important under extremes
    - Leaching
    - Volatilization (in the case of urea-based products)
    - Late freeze
    - Drought
  - Reduces risk of nitrate toxicity, too.

Benefits of Adding Legumes

A valuable source of N (time-released).

Species	Annual lbs (N/acre)	N value at $0.60/lb. of N
Alfalfa	200-300	$120-180
Red clover	100-200	$60-120
White clover	100-150	$60-90
Annual clover	50-150	$30-90



Another Fertilization Trick

Apply P in late summer or fall.

- P can essentially be applied any time during the year on established forage crops.
- Purchase P fertilizer in "off-peak" times of the year (i.e., summer and fall)
  - Demand for the product is low
  - Demand for spreading services is low
  - Less risk of P runoff

Another Fertilization Trick

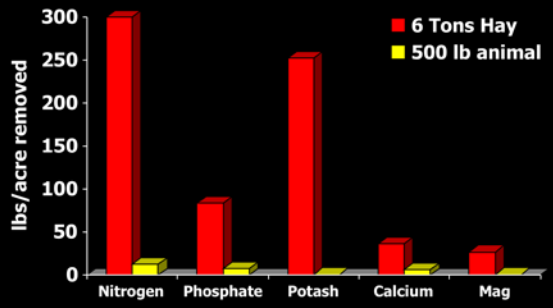
Split Your Potassium Applications!

40-50%
in the Spring

50-60%
in mid – late season

K is for Persistence

Nutrients removed per acre with bermudagrass hay or 500 lb animal



Adapted from S. Forages 3rd Ed.

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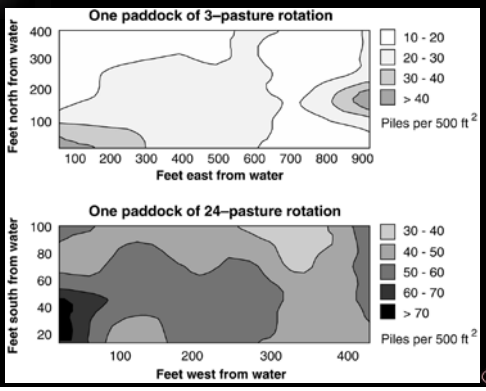
Benefits of Rational Grazing

1. Better utilization of forage
2. Growth rate of forage is optimized
   - Kept in linear/exponential growth phase
   - Higher yield of forage
3. Higher stocking rates
4. More animal gains/milk production per acre
5. Reduced feeding of conserved forage or supplements
6. Better persistence of desirable forages
   - Especially clover and legume species
7. Better weed suppression
8. Better manure distribution

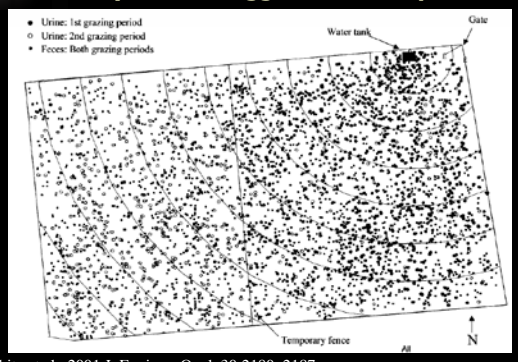
Manure Distribution



Manure Distribution

Rotation Frequency	Years to Get 1 Pile/sq. yard
Continuous	27
14 day	8
4 day	4 – 5
2 day	2

Efficiency of Four-legged Manure Spreaders



White et al., 2001 J. Environ. Qual. 30:2180–2187

Efficiency of Waste Management

Location	Time (% of Total)	Defecations (%)	Urinations (%)
Paddock	86.1	84.7	84.1
Feed Area	7.3	9.1	12.3
Lanes	2.6	1.3	0.0
Holding	1.7	4.4	3.4
Parlor	1.7	0.4	0.2
		4.8	3.6

White et al., 2001 J. Environ. Qual. 30:2180–2187

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